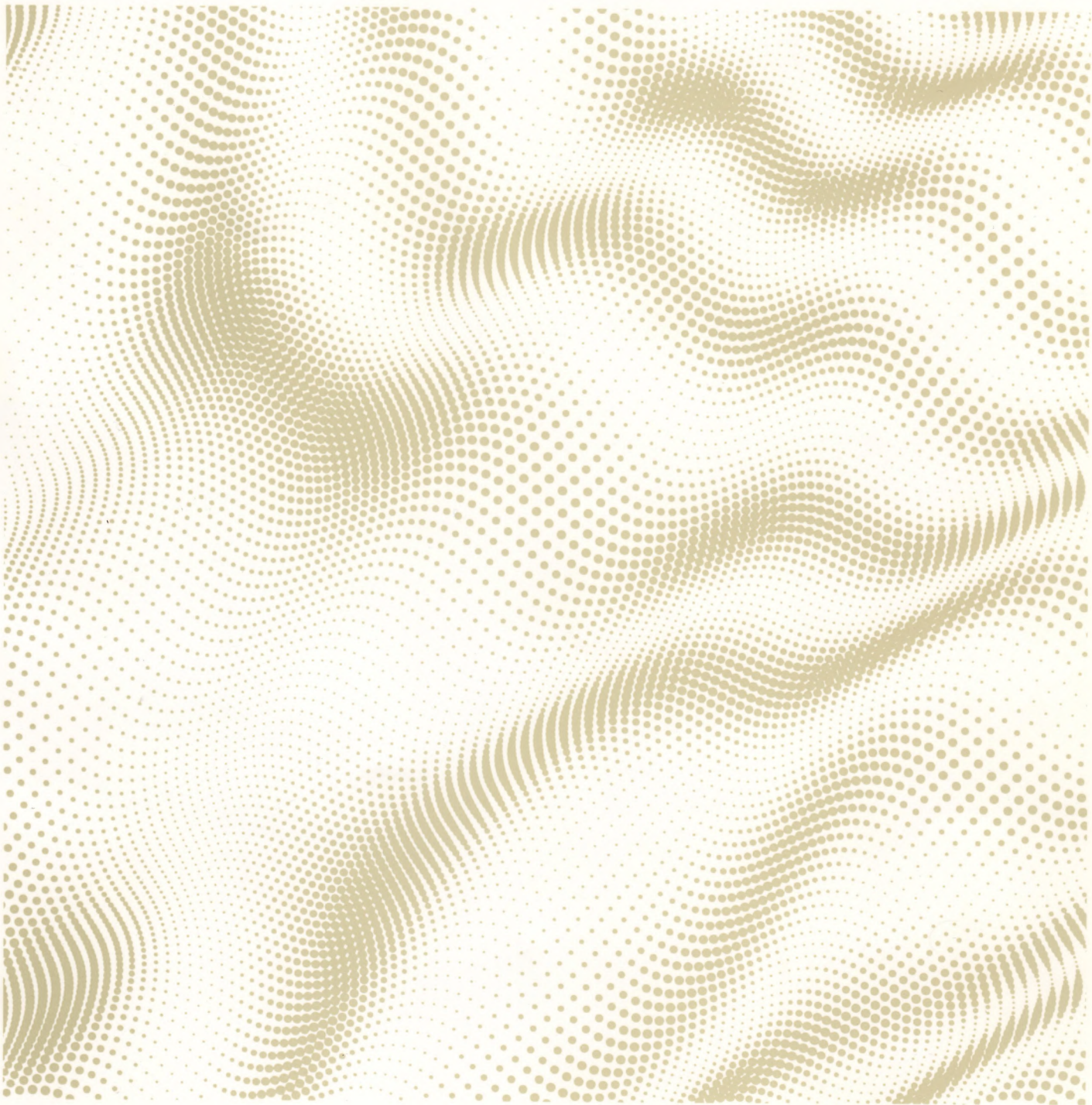
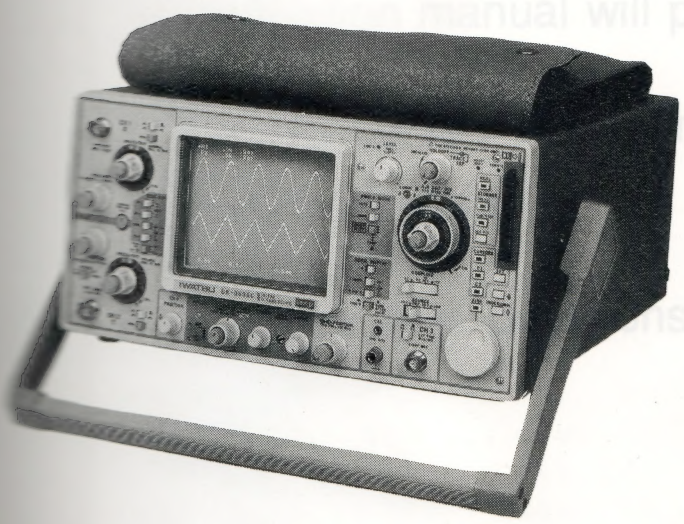
IWATSU

OPERATION MANUAL

DIGITAL STORAGE SCOPE

DS-8606C





OPERATION MANUAL

DIGITAL STORAGESCOPE

DS-8606C

C151-614101(L)

Introduction

Thank you for purchasing IWATSU's electronic measuring instrument.
We hope that you will patronize it as long as possible in the future.

- It would be ideal if you can operate any measuring instruments without referring to anything.
- When it comes to a highly advanced measuring instrument, however, you will need some help to operate it.
- The instruction manual will provide that help.
- IWATSU is always keen on preparing the user-friendly instruction manuals.
- If you have any questions, please do not hesitate to contact us.

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Cautions

Observe the following precautions in using DS-8606C:

☐ **Ambient Temperature and Ventilation**

DS-8606C operates normally in an ambient temperature range of 0°C to +40°C. Be sure to use it within this range. Using it outside this range may result in some trouble.

Do not place anything near ventilating holes of the cover, because it will block radiation of heat.

☐ **Supply Voltage Check**

Before plugging a power cord, check a supply voltage. DS-8606C can be used on the supply voltage shown in Table 1, which is set with the supply voltage selector on the rear panel. Check also the fuse in the rear panel in accordance with Table 1. If DS-8606C is used beyond a specified voltage range, it may go out of order.

Before changing over a voltage range or replacing the fuse, be sure to remove a power cord from an electrical outlet.

Table 1 Supply Voltage Ranges and Fuse Spec.

Set Position	Center Voltage	Voltage range	Fuse Spec.	Power Cord
A	100 V	90 V to 110 V	2A, slow-blow	For 100 V
B	115 V	103 V to 128 V		
C	220 V	195 V to 242 V	1A, slow-blow	For 200 V
D	230/240 V	207 V to 250 V		

☐ **Be Sure to Use Specified Fuses.**

DS-8606C uses the fuses shown in Table 1 to protect its circuits against damages caused by an overcurrent. If any of these fuses is burnt out, replace it with a specified one after checking the position of the supply voltage selector on the rear panel and the specification of the fuse. Never use fuses other than specified ones because it may cause not only a trouble, but also a danger.

☐ **Do Not Impress an Excessive Voltage.**

Each maximum input voltage is as follows.

Do not impress a higher voltage.

CH1·2·3 INPUT	±400 V MAX
EXT CLK INPUT	± 50 V MAX
Z AXIS INPUT	± 50 V MAX

☐ **Use the supplied power cord**

Use the supplied 3-wire power cord.

When operating DS-8606C on the line voltage from a 2-core electrical outlet with the supplied 3-wire power cord and a conversion adaptor, be sure to ground the ground terminal on the rear panel to prevent danger.

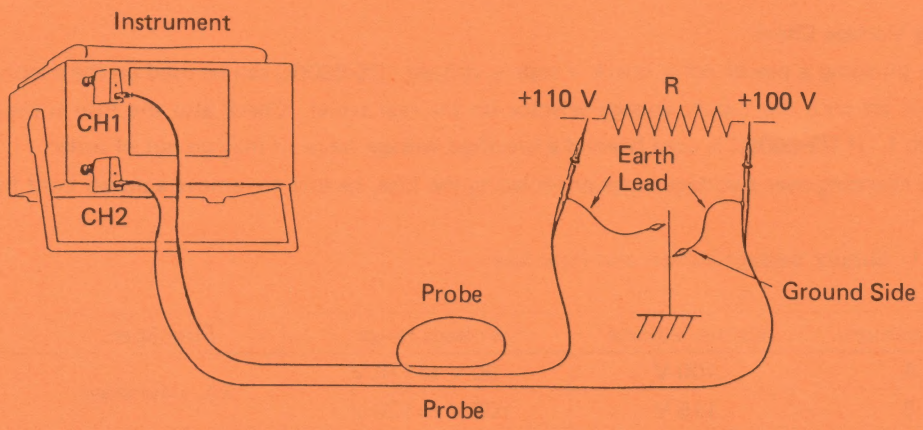
☐ **Observing the Signal Floating from Grounding**

The chassis is always grounded. So, if the ground terminal, etc. of the probe linked with the chassis is connected to a signal source by mistake, it will cause a trouble or damage with the instrument and the measuring circuit.

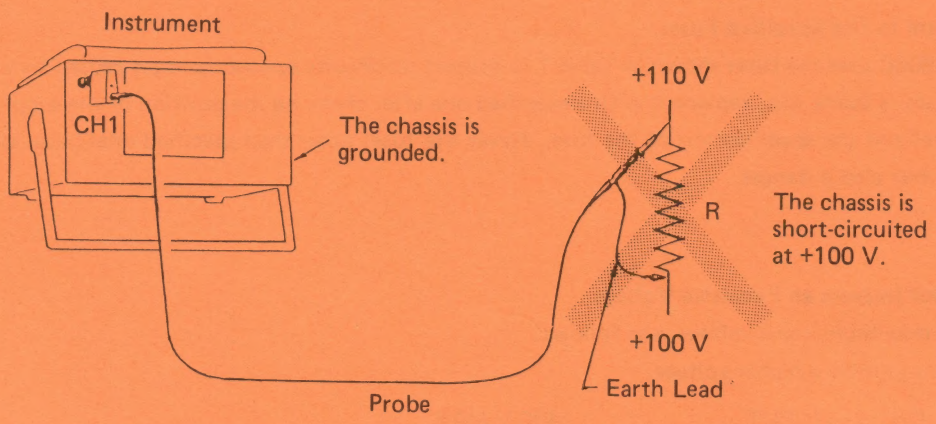
When observing a signal floating over the ground, be sure to adopt the differential input system (V mode and CH2 POLAR set to ADD and INV respectively, and two probes or two coaxial cables used).

Figure 1. Observation Example by Differential Method

[Good Example]



[Bad Example]



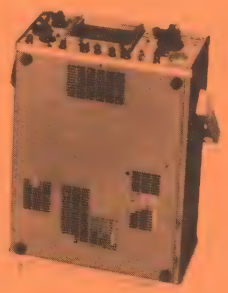
☐ **Do not increase intensity excessively**

Do not increase the intensity of traces or spot more than necessary. Excessive intensity can not only result in eyes fatique, but if left for a long time, it will burn the CRT phosphor surface.

☐ **Using DS-8606C with the CRT screen up**

DS-8606C can be used with the CRT screen up as shown in Figure 2. When used in this position, be careful not to make DS-8606C fall down by pulling hard on the probes connected to the signal input connector.

Figure 2. The CRT Screen Up



☐ **Preheating Time**

To satisfy electrical specifications given in Section 1, a preheating time of 30 minutes or more is required after turning on the power.

MEMO

Section 1 Specifications

1-1 GENERAL

DS-8606C, which combines a 20 M sample/sec digital storage and a DC to 60 MHz oscilloscope, is a test & measuring instrument.

It has many functions for cursor measurement, equivalent sampling, averaging, peak channel hold, GO/NO GO judgement, waveforms storage to memory card, and so on.

Features

- Equivalent sampling:
  A repetition signal can digitize sine waves of up to 60 MHz.
- Cursor measurements:
  Various measurement can be taken using cursors. Measured results are displayed on the screen.
- Averaging:
  Averaging in the range of 2 to 256 times is allowed in 8 steps.
- Interpolative display:
  Using two types interpolating functions, a waveform is displayed easier to view.
- Peak channel hold:
  Glitch detection and AM modulated wave measurement are provided.
- GO/NO GO judgment:
  An area judged is where two vertical cursors and a domain of the width of reference waveforms overlap.
- Hard Copy:
  Data can be plotted by the pen recorder or the plotter (GP-IB or RS-232C interface unit used).
- CRT readout:
  Measuring conditions and various modes are displayed on the CRT screen.
- Roll mode:
  A waveform can be continuously observed on the CRT screen as a low-speed signal monitor.
- Pretrigger:
  The phenomenon before the trigger point can be observed.
- Sweep delay, waveform enlargement and reduction (X axis: enlargement by SEC/DIV and X10 MAG, Y axis: enlargement and reduction by STORAGE VARIABLE) can be applied to a storage waveform as well as real waveform.
- Memory card:
  Maximum of 120 waveforms (30 waveforms for accessories) can be stored in a memory card.

1-2 ELECTRICAL SPECIFICATIONS

1-2-1 CRT

Shape	6-inch rectangular shape
Display area	8 div x 10 div (1 div = 10 mm) Non-parallax internal graduations with illumination
Phosphor	B31
Acceleration voltage	Approx. 12 kV

1-2-2 Vertical Deflection System

Mode	STORAGE OFF (REAL) CH1, CH2, ADD, DUAL/TRI (ALT, CHOP), X-Y CHOP switching frequence: Approx. 130 kHz STORAGE ON CH1, CH2, DUAL, REF
Channels 1 and 2	
Deflection factor	5 mV/div to 10 V/div 1-2-5 sequence of 11 steps Accuracy: ±2% (10°C to 35°C) 5 mV/div to 25 V/div Continuously variable with a fine regulator 1 mV/div to 2 mV/div (x 5 MAG ON) Accuracy: ±4% (10°C to 35°C)
Frequency band width	5 mV/div to 0.2 V/div: DC to 60 MHz –3dB (10°C to 35°C) 1 mV/div, 2mV/div (x 5 MAG ON) DC to 20 MHz –3dB (10°C to 35°C) [Note] Lower limit frequency for AC coupling: 4 Hz
Rise time	5.8 ns [Note] Rise time calculated from: bandwidth x rise time = 0.35
Square wave characteristics	At 5 mV/div Overshoot: 7% (10°C to 35°C) Sag (at 1 kHz): 2% (10°C to 35°C) Other distortions: 5% (10°C to 35°C)
Signal delay	With delay cable
Input coupling	AC, DC, GND
Input RC	Direct: 1MΩ ± 2% // 32 pF ± 3pF With probe: 10MΩ ± 2% // 21 pF ± 3pF
Max. input voltage	Direct: 400 V (DC + AC peak) With probe: 600 V (DC + AC peak)
Drift	30 min. after power-on (standard values) At 5 mV/div: 0.5 div/hour At 1 mV/div: 2.5 div/hour

Common mode rejection ratio	At 5 mV/div 40 : 1 or less (1 kHz sine wave) 15 : 1 or less (5 MHz sine wave)
Inversion	CH2 only
Channel 3	
Deflection factor	0.1 V/div Accuracy: ±3% (10°C to 35°C)
Frequency band width	DC to 60 MHz –3dB (10°C to 35°C) [Note] Lower limit frequency for AC coupling: 4 Hz
Square wave characteristics	Overshoot: 10% (10°C to 35°C) Sag (at 1 kHz): 3% (10°C to 35°C) Other distortions: 9% (10°C to 35°C)
Input coupling	AC, DC
Input RC	Direct: 1MΩ ± 2%//32 pF ± 8 pF With probe: 10MΩ ± 2%//21 pF ± 3 pF
Max. input voltage	Direct: 400 V (DC + AC peak) With probe: 600 V (DC + AC peak)

1-2-3 Triggering

Source	CH1, CH2, CH3, LINE [Note] External triggering is enabled by setting trigger source to CH3.
Coupling	AC, DC, HF, REJ, TV (A sweep: TV-V, B sweep: TV-H)
Slope	+, –
Maximum trigger level	(10°C to 35°C)

Frequency Range	Level	
	CH1 • CH2	CH3
DC to 5 MHz	0.5 div	1 div
5 MHz to 60 MHz	1.5 div	3 div

[Notes]

- Trigger signals are attenuated in the following frequency ranges depending on coupling
  AC 100 Hz or less
  HF REJ 10 kHz or more
- Auto sweep mode: The lower usable frequency is 50 Hz
- TV-V, TV-H synchronizing signal level: 1 div or more on screen amplitude for a composite video signal composed of 7 parts video signal and 3 parts synchronizing signal.

1-2-4 Horizontal Defelction System

1-2-4-1 STORAGE OFF (REAL)

Mode	A, A INTEN, ALT, B DLY'D
A Sweep	
Sweep mode	AUTO, NORM, SINGLE
Sweep time	50 ns/div to 0.5 s/div 1-2-5 sequence of 22 steps
	50 ns/div to 1.25 s/div Continuously variable with a fine regulator
	Accuracy I (over center 8 divisions): ±2% (10°C to 35°C)
	Accuracy II (over arbitrary 2 divisions within center 8 divisions):
	0.2 μs/div to 0.5 s/div ±5% (10°C to 35°C)
	50 ns/div, 0.1 μs/div ±7% (10°C to 35°C)
Holdoff time	Variable with a regulator
B Sweep	
Delay	Continuous delay (RUNS AFTER DELAY), Triggered delay (TRIG'D)
Sweep time	50 ns/div to 50 ms/div 1-2-5 sequence of 19 steps
	Accuracy I (over center 8 divisions): ±2% (10°C to 35°C)
	Accuracy II (over arbitrary 2 divisions within center 8 divisions):
	0.2 μs/div to 50 ms/div ±5% (10°C to 35°C)
	50 ns/div, 0.1 μs/div ±7% (10°C to 35°C)
Delay jitter	1/10,000 or less
Sweep magnification	10 times (max. sweep time: 5 ns/div)
	Accuracy I (over center 8 divisions)
	5 ns/div to 50 ms/div: ±5% (10°C to 35°C)
	[Note] 20 ns from a sweep start point and 40 ns from a sweep end point are excluded.
	Accuracy II (over arbitrary 2 divisions within center 8 divisions):
	20 ns/div to 50 ms/div ±6% (10°C to 35°C)
	5 ns/div, 10 ns/div ±10% (10°C to 35°C)

1-2-4-2 STORAGE ON

Mode	A, A INTEN, B DLY'D
A/B Sweep	
Normal storage	5 μs/div to 0.5 s/div
Roll mode	0.1 s/div to 500 s/div
Equivalent sampling	50 ns/div to 50 μs/div
Sweep magnification	Same as in 1-2-4-1

1-2-5 X-Y Operation

1-2-5-1 STORAGE OFF (REAL)

Input	CH1 for the X axis, CH2 for the Y axis
X axis	
Deflection factor	Same as that of CH1
	Accuracy: ±5% (10°C to 35°C)
Frequency band width	DC to 2 MHz –3 dB
Input RC	Same as that of CH1
Max. input voltage	Same as that of CH1
Y axis	Same as that of CH2
X-Y phase difference	3° or less (DC to 50 kHz)

1-2-5-2 STORAGE ON

X-Y axis	CH1 for the X axis/CH2 for the Y axis or REF1 for the X axis/REF2 for the Y axis.

1-2-6 Z-axis

Sensitivity	3 Vp-p
Slope	Positive-going signal decreases the brightness.
Frequency band width	DC to 3 MHz
Input resistance	10kΩ±20%
Max. input voltage	50 V (DC + AC peak)

1-2-7 CRT Readouts and Cursor Measurements

Readouts	The following parameters are displayed: CH1 deflection factor, CH2 deflection factor, CH3 deflection factor, REF 1 deflection factor, REF 2 deflection factor, A and B sweep times, sweep delay time, various modes
Cursor measurements	STORAGE OFF (REAL) ΔV, Δt, VOLTAGE RATIO, PHASE STORAGE ON ΔV, Δt, VOLTAGE RATIO, PHASE,PEAK TO PEAK, GO/NO GO, GND REFERENCE, MAX & MIN

1-2-8 Digital Storage

A/D converter	2
Resolution	8 bits
Max. conversion rate	20 M samples/sec
Data length	1 k word or 16 k words
Equivalent sampling	DC to 60 MHz
No. of averagings	2, 4, 8, 16, 32, 64, 128 and 256 times
Interpolation function	Linear and sine interpolations
GO/NO GO judgment	Setting with two vertical cursors and a wide waveform
Waveform output	
X-Y recorder	Automatically draws scales and waveforms.
Plotter	Recording of scales, waveforms setting conditions, cursor measured values and time counts
Waveform enlargement	
Vertical	X2/3 to X1.5
Horizontal	X1 to X100
Data position	11 steps (0 to 10 div)
EXT CLOCK IN	Level L : 0.6V or less, 40 ns or more H : 2.7V or more, 40 ns more Repeating frequency : 10 MHz or less

1-2-9 Memory Card

Functions

AUTO ADVANCE
AUTO COUNT UP
AUTO ADVANCE + GO/NO GO
Reference waveform of GO/NO GO

Types of card and Number of files

Types of card	Number of files	Data length
8K BYTE (Optional)	6 + 2 (Internal memory)	1 kword
16K BYTE (Optional)	14 + 2 (Internal memory)	1 kword
32K BYTE (Accessory)	30 + 2 (Internal memory)	1 kword
64K BYTE (Optional)	60 + 2 (Internal memory)	1 kword
128K BYTE (Optional)	120 + 2 (Internal memory)	1 kword

Time count (time count since POWER ON)

Accuracy	1 sec/hour ± 1 sec (Timing error for reading)

1-2-10 Signal Output

Calibrator	
Waveform	Square wave
Repetition frequency	1 kHz
	Accuracy: ±1% (10°C to 35°C)
Duty ratio	40 : 60
Output voltage	0.3 V
	Accuracy: ±1% (10°C to 35°C)
PEN X signal output	
Output voltage	Approx. 0.6 V per division of displayed signal
Output resistance	1 kΩ±20%
PEN Y signal output	
Output voltage	Approx. 0.6 V per division of displayed signal
Output resistance	1 kΩ±20%
PEN UP/DOWN output	
Output voltage	Approx. +5 V (reference voltage: approx. 0 V)
Output resistance	1 kΩ±20% at 0 V
	3.2 kΩ±20% at +5 V
GO/NO GO output	
Output voltage	Approx. +5 V (reference voltage: approx. 0 V)
Output resistance	1 kΩ±20%

1-2-11 Power Supply

Voltage range	100 (90 to 110)/115 (103 to 128)/220 (195 to 242)/230, 240 (207 to 250) V AC
	Respective voltage ranges can be selected with an voltage selector (A/B/C/D).
Frequency range	50 to 400 Hz
Power consumption	Approx. 100W (at 100 V AC)

1-3 DIMENSIONS AND WEIGHT

Weight	Approx. 11.5 kg
Dimensions	(320 ± 2) W x (160 ± 2) H x (420 ± 2) L (mm)

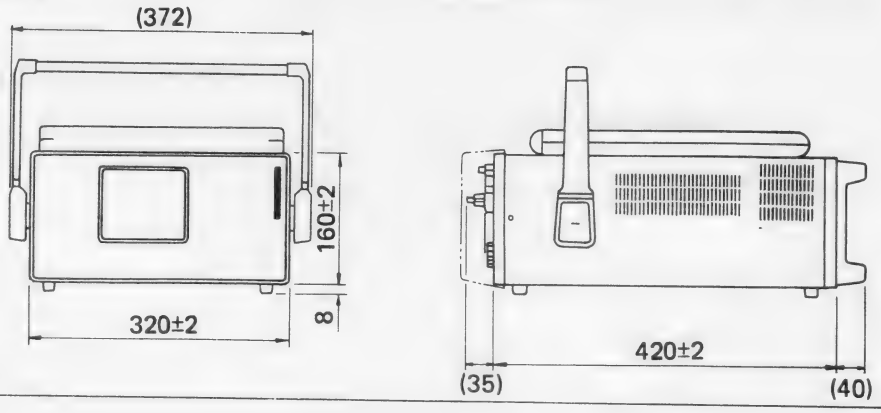
1-4 ENVIRONMENTAL CHARACTERISTICS

Temperature	
Operating	0°C to +40°C
Non-operating	−20°C to +70°C
	[NOTE] −20°C to +60°C for memory cards
Humidity	
Operating	Up to 90% relative humidity at 40°C
Non-operating	Up to 80% relative humidity at 70°C
Altitude	
Operating	5,000 m (atmospheric pressure 405 hPa)
Non-operating	15,000 m (atmospheric pressure 90 hPa)
Vibration	Vibrated in three orthogonal axes for 15 minutes per axis; 0.63 mm peak-to-peak excursion; 10 to 55 Hz. 1 minute/octave sweep.
Impact	Raise one side 10 cm up (an elevation angle of 30° at maximum) and let it fall on a piece of hard wood. Try this test 3 times for each side.
Drop	After packing the product for transportation, drop it from a height of 90 cm.

1-5 ACCESSORIES

SE-501 S-RAM 32 k Byte	1
Power cord	1
Fuse	2
Panel cover	1
Dust cover	1
Accessories bag	1
Instruction manual	1

Figure 1-3. Dimensions



Section 2 Installation

2-1 ENVIRONMENTAL CONDITIONS

Operating conditions are as follows:

Temperature	0°C to 40°C
Humidity	Up to 90% RH at 40°C
Atmosphere	No corrosive gas should be contained.
Altitude	5,000 m (atmospheric pressure 405 mmHg)

CAUTION

To secure proper ventilation, do not place anything near a ventilation hole or a fan.

2-2 AC POWER

Supply voltage:

The supply voltage is set to 100 V AC (center voltage) when not specified. When the supply voltage is required to be changed after the product is delivered, you can change the voltage range by altering the setting of the AC input voltage selector located on the rear panel in the procedure shown on the right.

Table 2-2 Supply Voltage Ranges

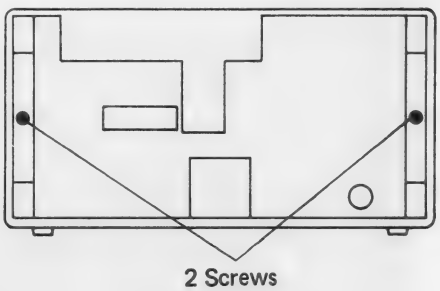
Set Position	Center Voltage	Voltage Range	Fuse
A	100 V	90 V to 110 V	2A SLOW
B	115 V	103 V to 128 V	
C	220 V	195 V to 242 V	1A SLOW
D	230/240 V	207 V to 250 V	

Frequency range: 50 to 440 Hz
Power consumption: Approx. 100W

Setting the AC Input Voltage Selector

Procedure

① Remove the supply cord.



② Remove two screws which fix the rear panel.
③ Remove the rear panel.
④ The plug of AC input voltage selector can be detached by pulling it to this side.
⑤ Insert the plug of AC input voltage selector into a desired voltage indicated position.
⑥ Remount the real panel.
⑦ Fix the rear panel with two screws.

2-3 PROTECTIVE GROUND TERMINAL

The instrument is provided with a 3-wire power cord.

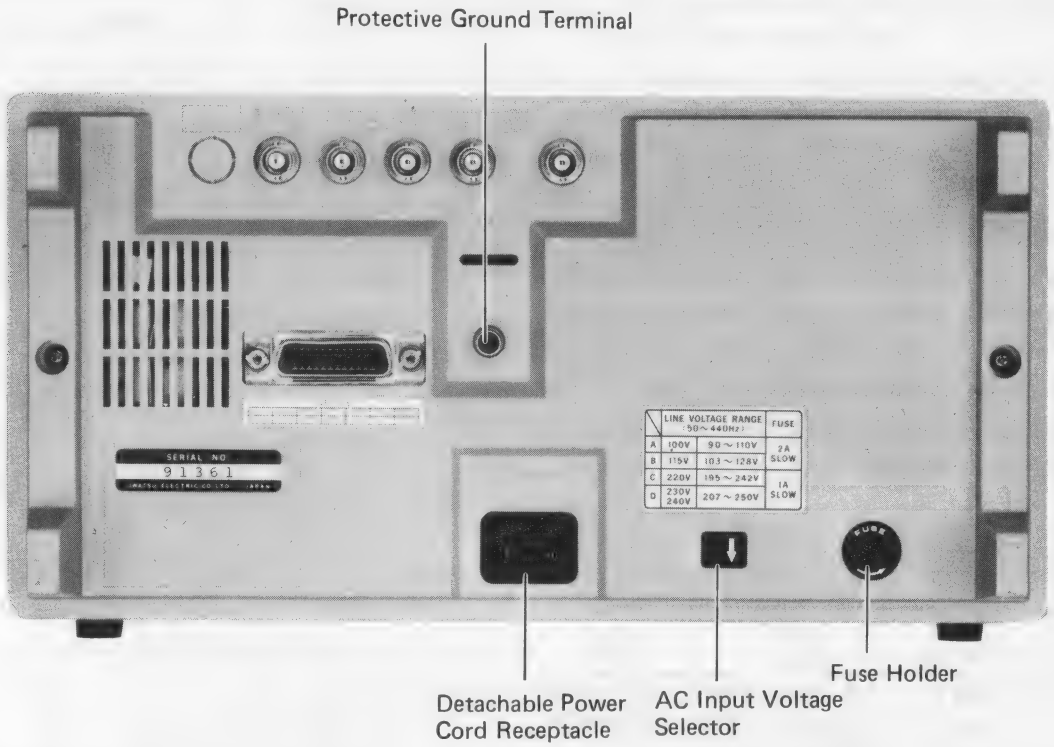
- When supplying the supply voltage from the 2-wire power receptacle with a 3-pin/2-pin conversion adapter, strictly observe the following caution:

CAUTION

Be sure to ground the ground terminal of the conversion adapter or that on the rear panel in order to avoid a danger.

- When supplying the supply voltage from the 3-wire power receptacle without using the 3-pin/2-pin conversion adapter, it provides a ground for the chassis of the instrument.

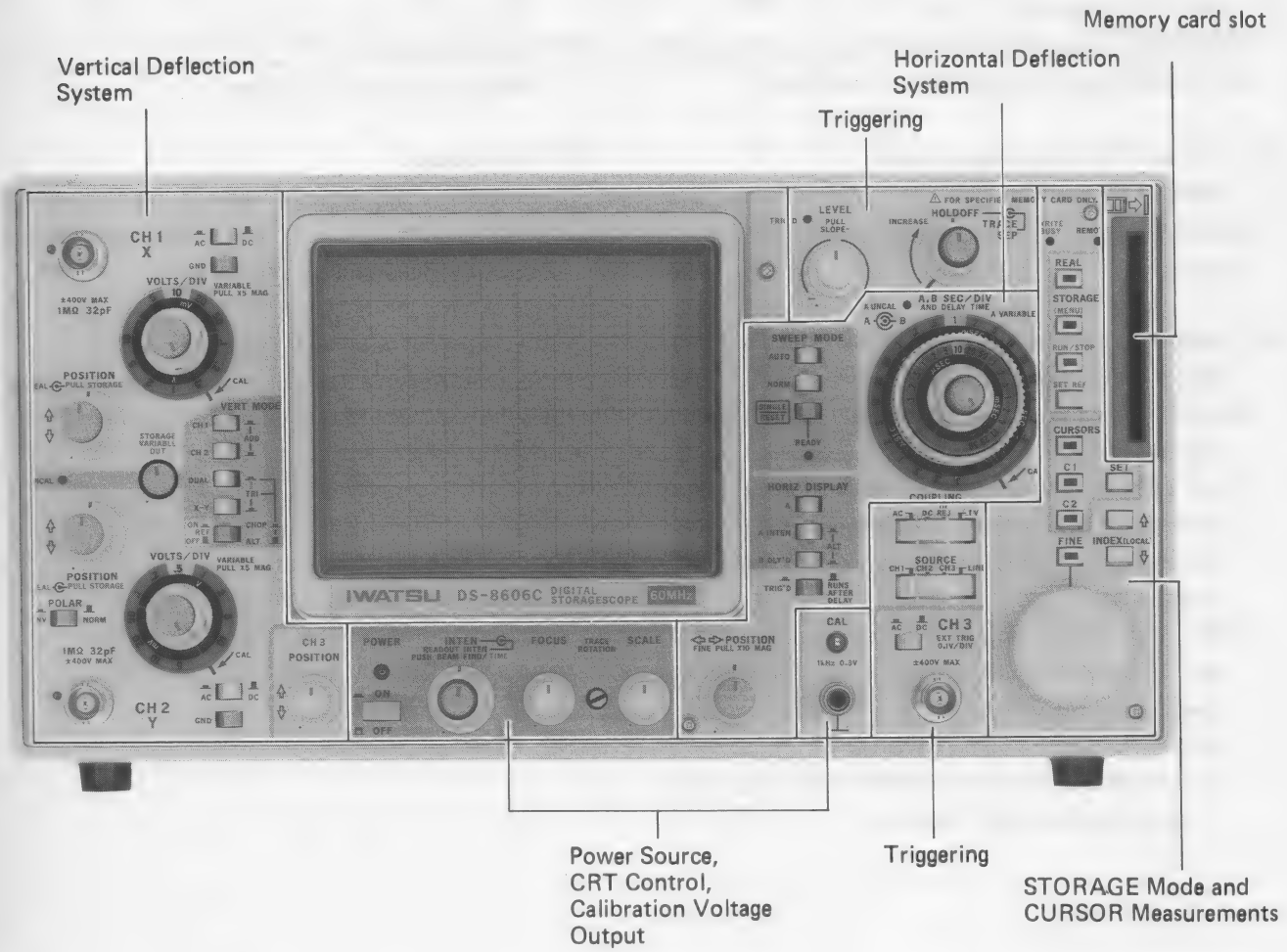
Figure 2-3. Rear Panel



Section 3 Controls, Connectors and Indicators

3-1 FRONT PANEL

Figure 3-1. Front Panel



3-1-1 Power Supply, CRT and Calibration Voltage Output

① **POWER Switch**

A push-push switch used to turn the instrument power on and off. It must be pushed in to apply power to the instrument and pushed in again to release the switch and remove power from the instrument.

② **Power On Indicator**

Illuminates when POWER switch is set to the "on" position and power is applied to the instrument.

③ **INTENSITY Control (Outer knob)**

Adjusts brightness of the CRT trace display. This control does not affect intensity of the CRT readout display.

④ **READOUT INTEN Control (PUSH BEAM FIND/ TIME Switch), (Inner knob)**

READOUT: Adjusts the brightness of the CRT readout and cursor displays.

PUSH BEAM FIND: When held in, the display is compressed to within the graticule area and a visible viewing intensity is provided to aid in locating off-screen displays.

TIME: When this knob is pressed at the storage mode, the following cumulative time is displayed on the lower left of the screen.

a. Cumulative time since POWER ON

b. Cumulative time since POWER ON when waveform is stored in REF memory.

⑤ **FOCUS Control**

Adjusts for optimum display definition.

⑥ **TRACE ROTATION Control**

Screwdrive control used to align a baseline trace with the horizontal graticule lines.

⑦ **SCALE Control**

Adjusts graticule illumination.

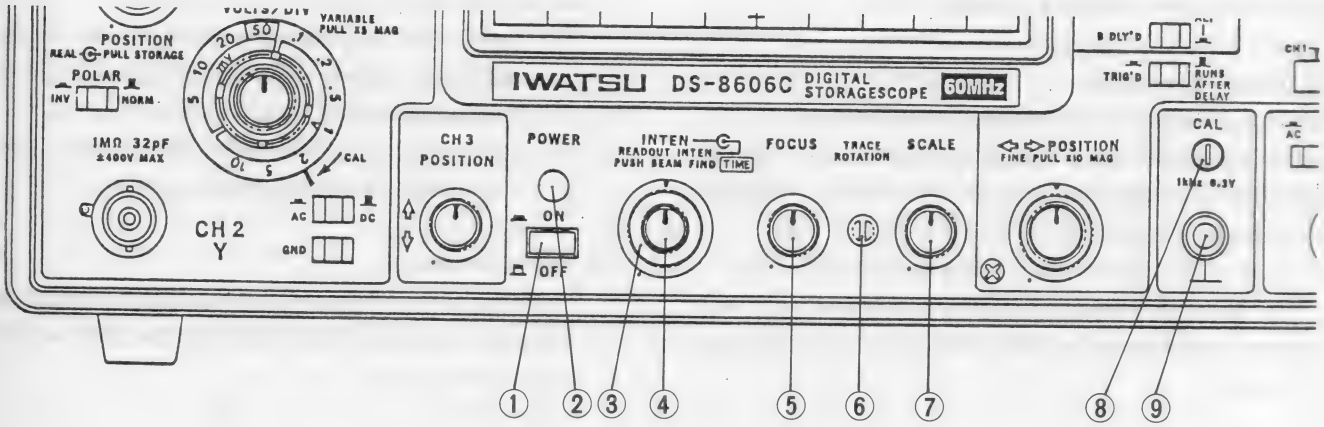
⑧ **CAL Output**

Provides a 0.3 V squarewave voltage signal with a repetition rate of 1 kHz. It is useful for checking the sweep, the delay and the vertical deffection factor.

⑨ ⊥ **(Ground terminal for measurement)**

Ground terminal for measurement. Connect it to the ground terminal of the circuit to be measured.

Figure 3-1-1. Power Supply, CRT Control and Calibration Voltage Output



3-1-2 Vertical Deflection System

CH1 and CH2

⑩ **INPUT Connectors**

Inputs a signal to be measured at CH1 or CH2.

A maximum input voltage is 400 V when directly inputting a signal and is 600 V at a probe tip when the probe is used.

However, it is 400 V MAX. when AC-DC is set to AC.

In the X-Y mode, CH1 INPUT serves as an X-axis input terminal and CH2 INPUT as a Y-axis input terminal.

⑪ **VOLTS/DIV Switches (Outer knob)**

Selects a vertical deflection factor.

The vertical deflection factor can be selected in 11 steps; 5 mV/div to 10 V/div.

⑫ **VARIABLE Controls (PULL x 5 MAG Switches) (Inner knob)**

VARIABLE: Provides variable uncalibrated deflection factors between the calibrated settings of the VOLTS/DIV.

PULL x 5 MAG: Pulling to the knob multiplies a vertical deflection factor 5 times. It allows you to set 1 mV/div and 2 mV/div.

⑬ **UNCAL Indicator**

Illuminates up when VARIABLE of CH1 or CH2 is set to a position other than CAL (uncalibrated).

⑭ **STORAGE VARIABLE Control (OUT)**

In position: The vertical deflection factor is fixed in the STORAGE mode.

Out position: The vertical deflection factor can be changed within a range of 2/3 to 1.5 times in the STORAGE mode.

⑮ **REAL POSITION Control (Outer knob)**

Adjusts a vertical position in the REAL mode.

⑯ **PULL STORAGE POSITION Control (Inner knob)**

Adjusts a vertical position in the STORAGE mode.

⑰ **AC-DC Switches**

Selects the method of coupling input signal to the vertical deflection system.

AC: Signals are capacitvely coupled to the vertical deflection system. The DC component of the input signal is blocked.

DC: All frequency components of the input signal are passed to the vertical input amplifier.

⑱ **GND Switches**

The input of the vertical deflection system is grounded. This allows you to check a ground potential (measurement reference level).

⑲ **CH2 POLAR Switch**

Displays the signal applied to CH2 INPUT with a polarity inverted.

CH3

⑳ **CH3 POSITION Control**

Adjusts a CH3 vertical position.

㉑ **CH3 INPUT Connector**

Inputs a signal to be measured at CH3. A maximum input voltage is the same as that for CH1 and CH2.

Also available for EXT TRIG.

㉒ **CH3 AC-DC Switch**

Selects the method of coupling input signal to the vertical deflection system.

See ⑰ AC-DC Switches.

Modes

㉓ **MODE Switch**

CH1 : Displays only the signal applied to CH1 INPUT.

CH2 : Displays only the signal applied to CH2 INPUT.

ADD : Displays an algebraic sum (CH1 + CH2) of signals applied to CH1/CH2 INPUT. When CH2 POLAR is set to INV, an algebraic difference (CH1–CH2) is displayed.

DUAL : Displays signals applied to CH1 and CH2 respectively.

TRI : Displays signals applied to CH1, CH2 and CH3 respectively.

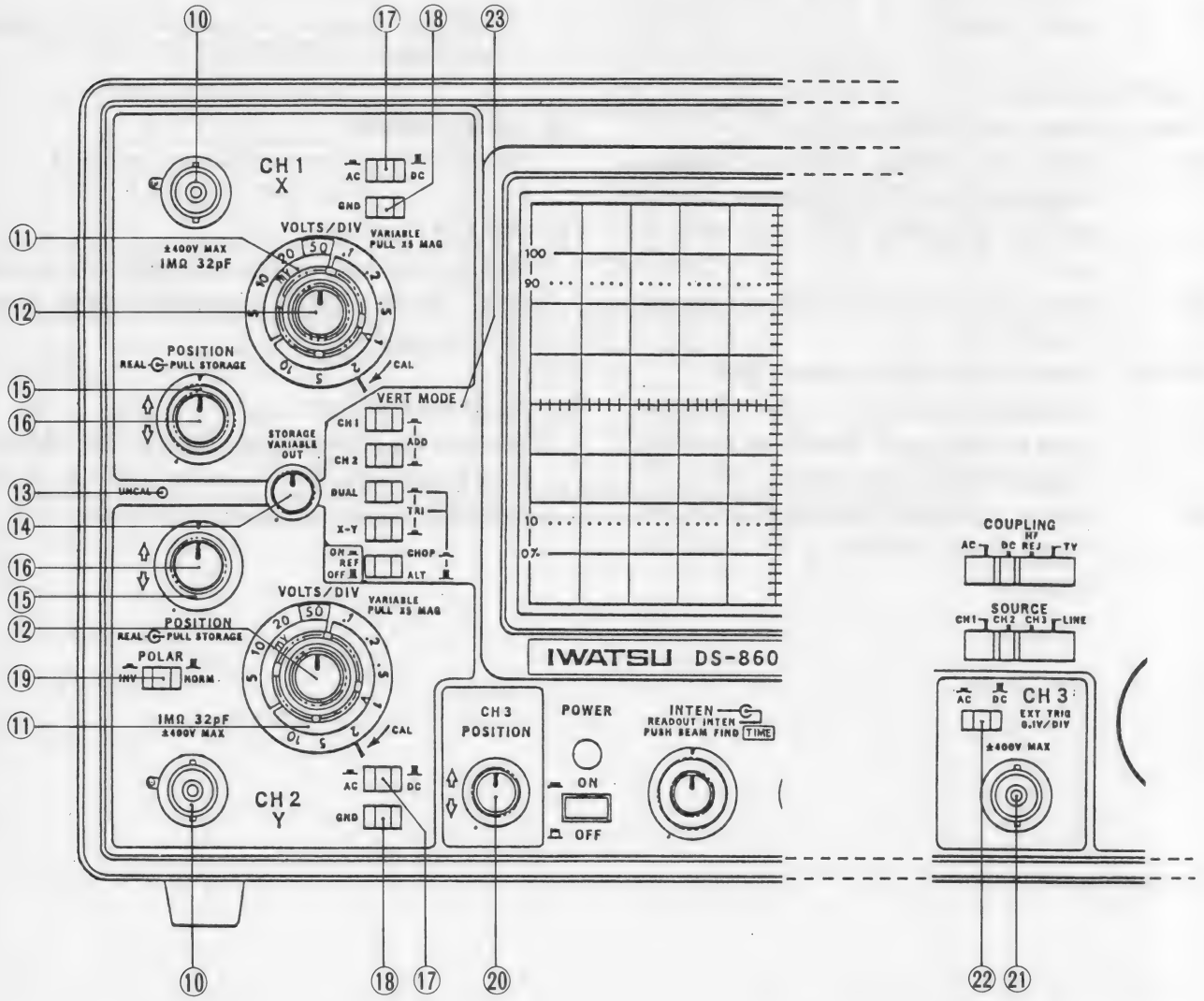
ALT : Alternately sweeps CH1 and CH2 in case of DUAL, and CH1, CH2 and CH3 in case of TRI. Suitable for observation when a sweep time is comparatively quick.

CHOP : Selectively displays CH1 and CH2 in case of DUAL, and CH1, CH2 and CH3 in case of TRI at about 130 kHz. Suitable for observation when a sweep time is comparatively slow.

X-Y : Displays a signal applied to CH1 for the X axis and that applied to CH2 for the Y axis.

REF : Switches a reference memory display on/off in the STORAGE mode.

Figure 3-1-2. Vertical Deflection System



3-1-3 Triggering

㉔ SOURCE Switch

Selects a trigger signal source.

CH1 : The input signal applied to CH1 INPUT results in a trigger signal.

CH2 : The input signal applied to CH2 INPUT results in a trigger signal.

CH3 : The signal applied to CH3 INPUT (EXT TRIG) results in a trigger signal.

LINE : The signal of the power line results in a trigger signal. Used when observing a supply frequency signal or higher harmonics of supply frequency.

㉕ COUPLING Switch

Selects a trigger circuit coupling method.

AC : Selects AC coupling. Capable of triggering regardless of the DC component, because the DC component of a trigger signal is cut.

DC : Selects DC coupling. Capable of triggering from DC.

HF REJ : Selects coupling with a low-pass filter. Frequency components of about 10 kHz or more are attenuated. Suitable for observing a signal containing high-frequency noises.

TV : Selects a coupling method in which the trigger circuit stabilizes a TV signal for triggering.

㉖ CH3 (EXT TRIG) INPUT Connector

Serves as an external trigger input terminal when SOURCE is set to CH3.

㉗ LEVEL Control and SLOPE (PULL—) Switch.

Level: Selects the amplitude point on the trigger signal at which the sweep is triggered.

Slope: Selects the slope of the signal that triggers the sweep.

+ (plus): Sweep can be triggered from the positive-going portion of a trigger signal.

— (minus): Sweep can be triggered from the negative-going portion of a trigger signal.

㉘ TRIG'D Indicator

Illuminates to indicate the A Sweep is triggered.

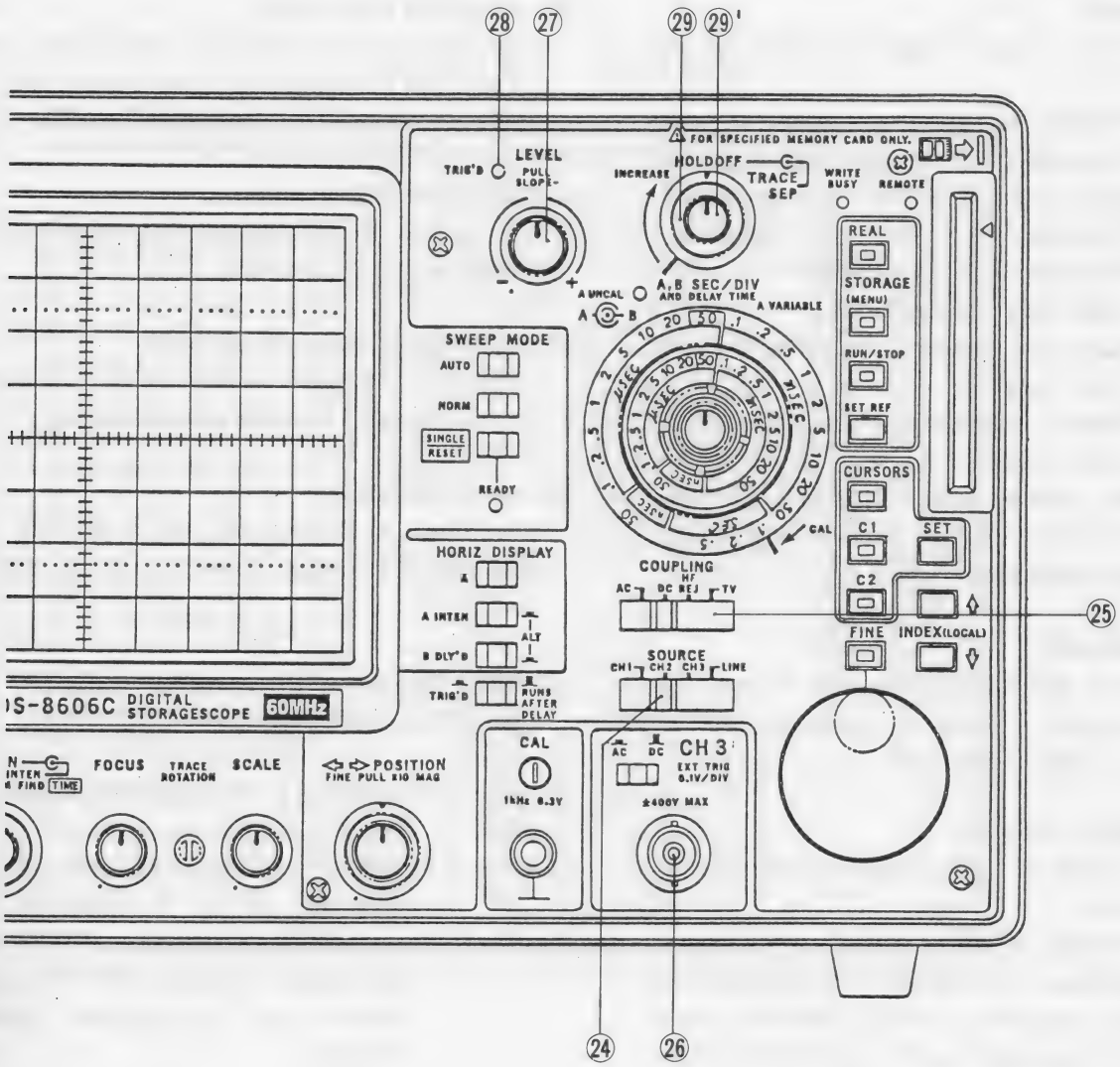
㉙ HOLDOFF Control

Provides continuous control of holdoff time between sweeps. Allows triggering on a periodic signals such as composite waveform.

㉙' TRACE SEP Control

Positions the B Sweep trace vertically with respect to the A Sweep trace when the HORIZ DISPLAY is ALT in the REAL mode.

Figure 3-1-3. Triggering



3-1-4 Horizontal Deflection System

㉚ MODE Switch

Determines the mode of trigger operation for the instrument.

AUTO : Permits triggering on waveforms with a repetition rate of about 50 Hz or greater. Sweep free runs and provides a bright baseline when either an adequate trigger signal is absent, or if the repetition rate of the trigger signal is below 50 Hz.

NORM : Sweep is initiated when an adequate trigger signal is applied.

SINGLE : Sweep is initiated one time when an adequate trigger is applied. Sweep cannot be initiated again until the sweep logic is reset through an adequate trigger signal by pressing the SINGLE RESET .

㉛ READY Indicator

Illuminates in the SINGLE mode to indicate that the sweep circuitry is armed and ready to initiate the sweep when a trigger signal occurs.

㉜ HORIZ DISPLAY Switch

Select the mode of operation for the horizontal deflection system.

A : Displays only the A Sweep.

A INTEN: Displays the A Sweep at a rate determined by the setting of the A TIME/DIV switch. An intensified portion corresponding to the length and position of the B Sweep will appear on the trace when the B Sweep is properly triggered.

B DLY'D: Displays only the B Sweep.

ALT (A INTEN and B DLY'D): Alternates the display between the A INTEN and B DLY'D sweep.

TRIG'D (Triggered delay): Initiates the B sweep with the first trigger pulses after the time set with A SEC/DIV and DELAY TIME.

RUNS AFTER DELAY (Continuous delay): Allows you to set a delay time as desired.
Although it allows you to start the B sweep from any position of the A sweep, a delay jitter may appear if a magnification is increased too much.

㉝ A SEC/DIV (Outer knob)

Provides a 22-step selection from 50 ns/div up to 0.5 s/div in a 1-2-5 sequence. A setting range is 0.1 s/div to 500 s/div in the ROLL mode for STORAGE.

㉞ B SEC/DIV (Middle knob)

Provides a 19-step selection from 50 ns/div up to 50 ms/div in a 1-2-5 sequence.

㉟ A VARIABLE Control (Inner knob)

Provides continuously variable uncalibrated A sweep rates to at least 2.5 times the calibrated setting.

㊱ UNCAL Indicator

Illuminates to indicate that the A SEC/DIV is uncalibrated (VARIABLE control is out of calibrated position).

㊲ POSITION Control (Outer knob)

Adjusts horizontal position coarsely.

㊳ FINE Control (PULL x 10 MAG) Switch (Inner knob)

FINE : Adjusts horizontal position finely.

PULL x 10 MAG: Increases the displayed sweep rate by factor of 10. The magnified sweep expands the center division of the unmagnified display. Indicator LED illuminates to indicate that the horizontal display is magnified.

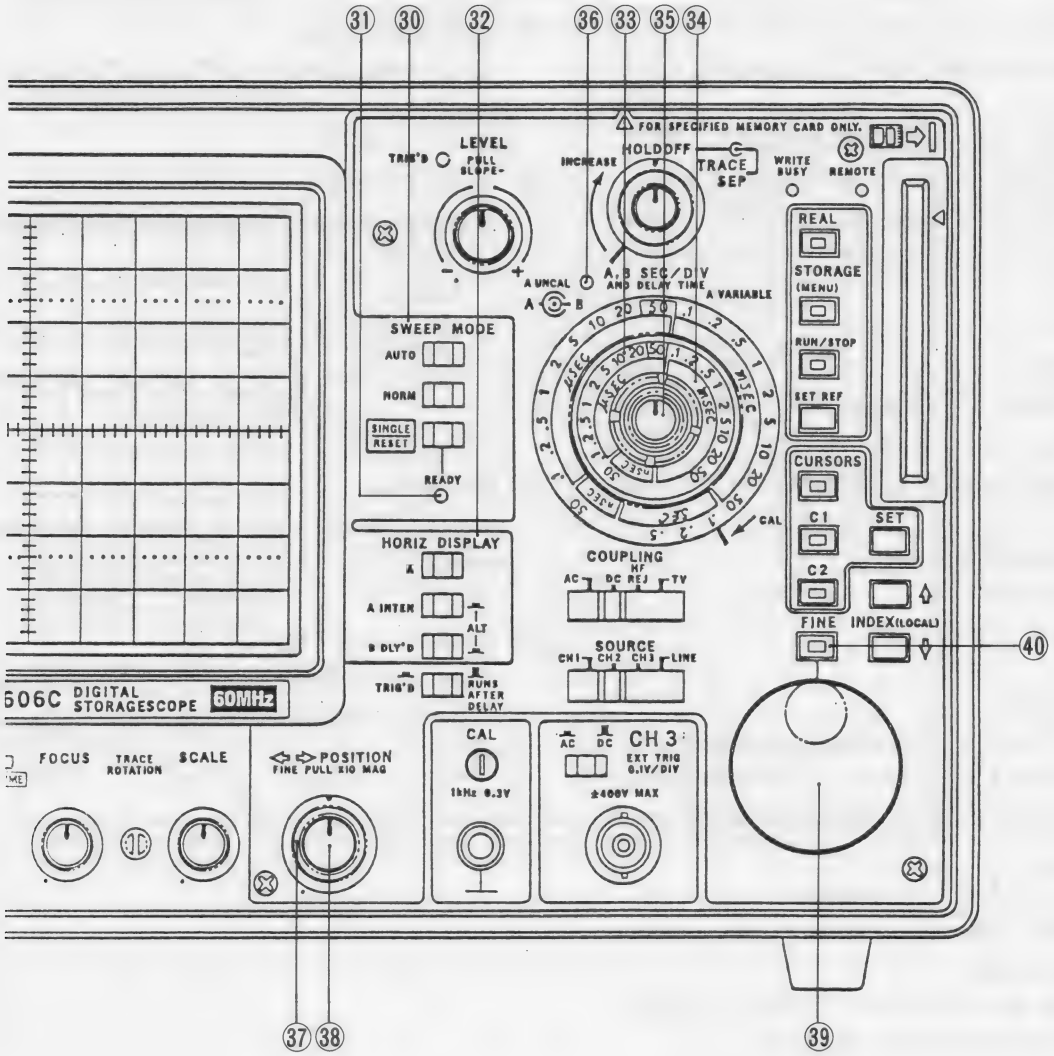
㊴ Rotary encoder

Uses menu selection in the STORAGE mode, cursor measurements and adjustment of a delay time.

㊵ FINE

Fine adjustment when using the rotary encoder.

Figure 3-1-4. Horizontal Deflection System



3-1-5 STORAGE Mode and Cursor Measurement

Storage

㊶ REAL-STORAGE Control

Switches from the REAL mode to STORAGE mode and vice versa.

REAL LED ON : Indicates the REAL mode.

STORAGE LED ON: Indicates the STORAGE mode.

Every time [STORAGE] is pressed, the Measurement screen and the Menu screen are switched over alternately.

㊷ SET REF Switch

Shifts the contents of memories CH1 and CH2 to REF1 and REF2.

According to the V. mode, the contents of the following is shifted:

Only CH1 in case of CH1

Only CH2 in case of CH2

CH1 and CH2 in case of DUAL

㊸ RUN/STOP Switch

When the LED is lit up, writing and reading-out are repeated. When the LED is lit off, a written waveform is continuously displayed as it is, without newly writing.

㊹ INDEX [⇧] [⇩] Switches

INDEX : Selects measuring conditions, etc. on the Menu screen.

LOCAL : Made to Local (the condition enabling panel operation) from REMOTE.

Cursor

㊺ CURSORS Switch

Cursor measurements are allowed when the LED is lit up.

㊻ C1 and C2 Switches

Selects the cursor to be moved in cursor measurements.

[C1] lit up: A broken line (— — —) is moved.

[C2] lit up: A dotted line (· · · · ·) is moved.

[C1] and [C2] lit up: Both lines are moved simultaneously.

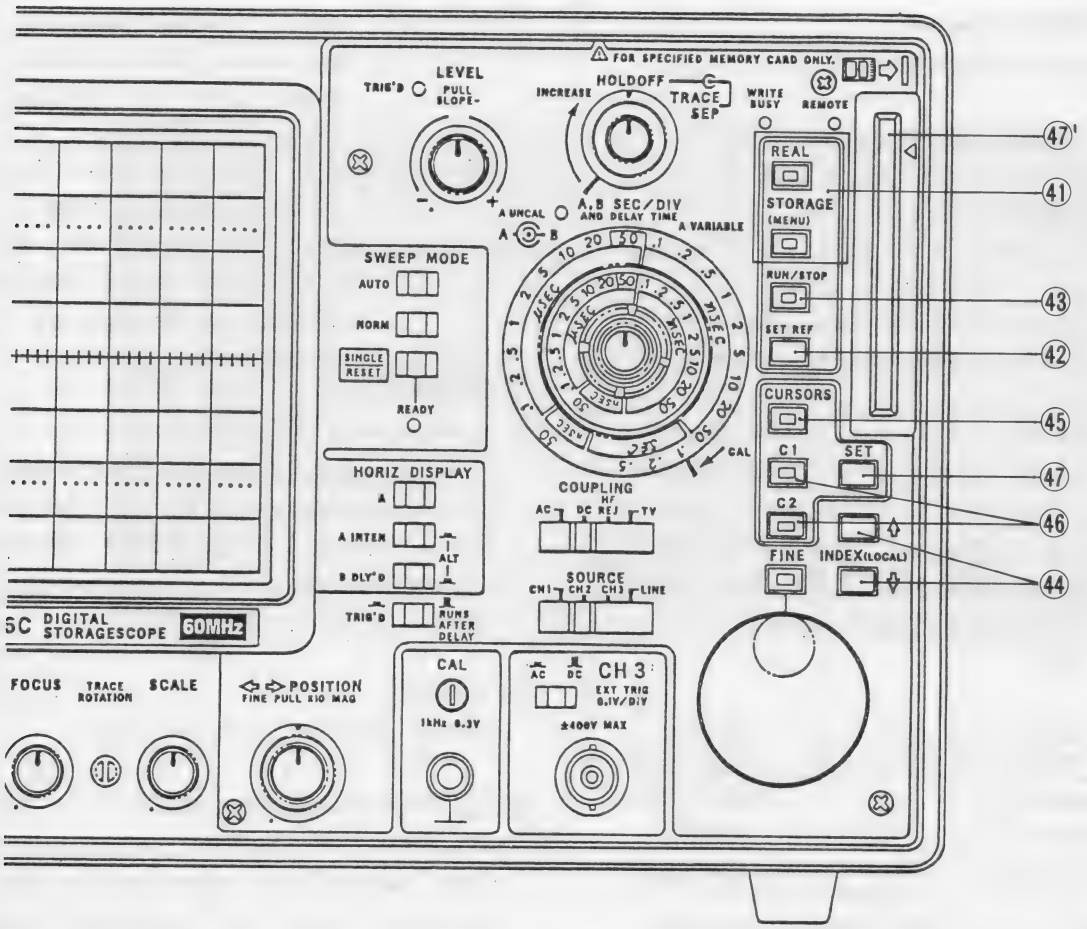
㊼ SET Switch

Sets a reference value and selects the cursor to be moved.

㊼′ Slot for Inserting Memory Card

Insert the memory card by matching the guide (◁mark) on the panel face and that (▷mark) on the card.

Figure 3-1-5. STORAGE Mode and Cursor Measurement



3-2 REAR PANEL

㊽ EXT CLK INPUT Connector

Inputs the external clock signal.

Clock signal

Low level : 0.6V or less, 40 ns or more

High level : 2.7V or more, 40 ns or more

Max. repeating frequency : 10 MHz

Maximum input voltage is ±50 V MAX.

㊾ *NO GO OUT and *SYNC OUT Connectors

Outputs the following waveforms when setting GO/NO GO.

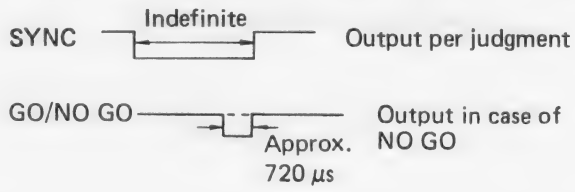
*NO GO OUT: Fetches data upon setting GO/NO GO and outputs a GO/NO GO judgment result per cycle. Negative pulses of about 720 μs are output for NO GO.

*SYNC OUT: Outputs a trigger signal in case of GO/NO GO judgment.

Table 3-2

Output	Output Voltage	Description	Output Resistance
NO GO OUT	Approx. 5 V	GO	3.3kΩ±20%
	Approx. 0 V	NO GO	1kΩ±20%
SYNC OUT	Approx. 5 V	Not being judged	3.3kΩ±20%
	Approx. 0 V	Being judged	1kΩ±20%

Output Waveform Timing Chart



㊾ REC X OUT, ㊿ REC Y OUT, (51) PEN UP OUTPUT Connectors

Output the signals to drive the pen recorder.

REC X OUT : Outputs analogue signal for X-axis of pen recorder. Output voltage is approximately 0.6 V per division. Output resistance is 1 kΩ±20%.

REC Y OUT : Outputs analogue signal for Y-axis of pen recorder. Output voltage is approximately 0.6 V per division. Output resistance is 1 kΩ±20%.

PEN UP OUTPUT: Outputs the pen-up signal for pen recorder. Output voltage is approximately 5 V on UP side, and 0 V on DOWN side. Output resistance is 3.2 kΩ±20% on UP side and 1 kΩ±20% on DOWN side.

(52) Z AXIS INPUT Connector

Provides an input connection point to apply external Z-axis modulation signals to the Z-Axis Amplifier.

A maximum input voltage is ±50 V, a frequency range is from DC to 3 MHz, and an input resistance is 10 kΩ ± 20%.

(53) REMOTE

GP-IB or RS-232C interface connector

(54) ⏚ (Protective ground terminal)

It is used for protection. When power receptacle is not made of 3-wire power cord, be sure to make grounding of this terminal for preventing the danger.

(55) Detachable Power Cord Receptacle

Provides the connection point for the AC power source to the instrument.

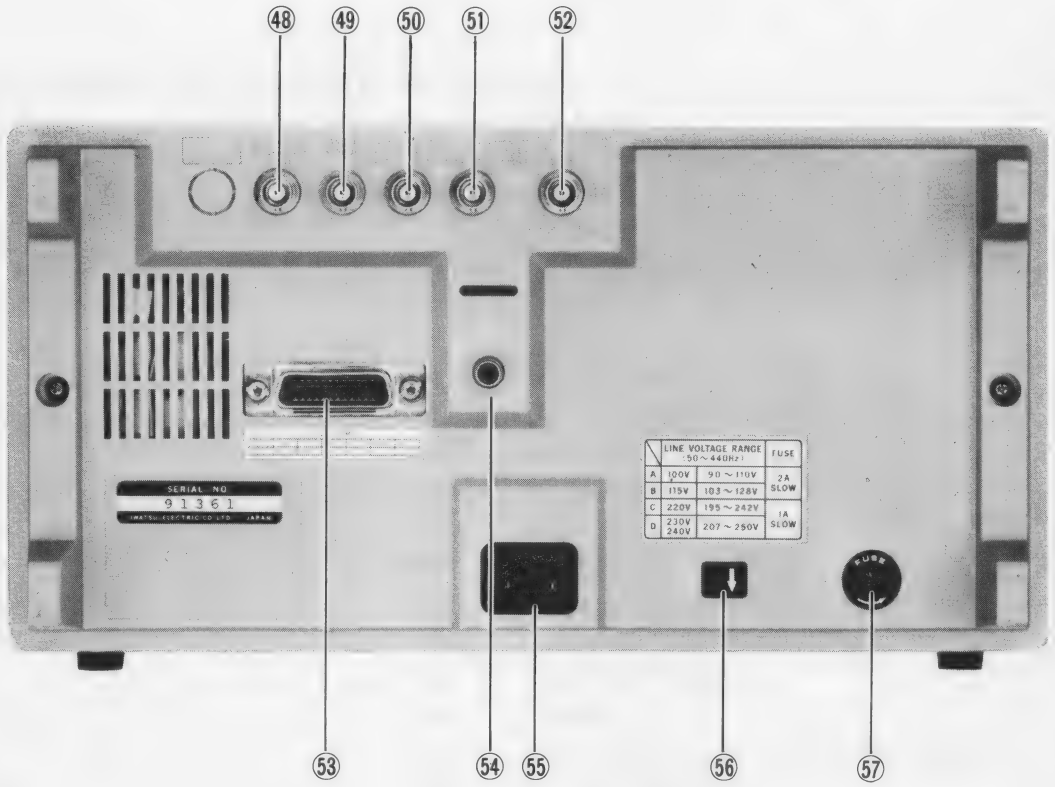
(56) LINE VOLTAGE SELECTOR Switch

To select desired line voltage, position the arrow mark of changeover plug to either one of A·B·C·D. Refer to the list labeled "line voltage range". Before changing line voltage, be sure to disconnect the power cord and to dismount the rear panel.

(57) FUSE holder

Contains the primary AC power fuse.

Figure 3-2. Rear Panel



MEMO

Section 4 Operation

First, output a CAL waveform on the screen, using an accessory probe.
Next, check the functioning of each component unit, using CAL signal mainly.
The procedures for the STORAGE mode and the measurement by cursors are mentioned as follows.

Operation Guide

4-1 PREPARATIONS BEFORE TURNING ON THE POWER

Procedure

① Accessories required

Power cord 1

Probe 1

② Checking the position of the AC input voltage selector

Check that the setting position of the selector matches the supply voltage used. (See Fig. 4-1-1.)

If not properly set, adjust it to a correct position, seeing "Section 2, 2-2 AC Power".

③ Setting the POWER switch to OFF

Set the POWER switch to OFF. (See Fig. 4-1-2.)

④ Setting the operation switches, etc. on the front panel

Set the operation switches, etc. on the front panel as follows: (See Fig. 4-1-2.)

Vertical axis:

MODE	CH1
CH1 VOLTS/DIV	5 mV
CH1 AC-DC	AC
CH1 GND	OFF (⊥)
CH1 POSITION	Midrange

Triggering:

SOURCE	CH1
COUPLING	AC
LEVEL	Midrange

Horizontal axis:

MODE	AUTO
HORIZ DISPLAY	A
A SEC/DIV	0.5 ms
POSITION	Midrange

CRT control:

INTEN	Midrange
READOUT INTEN	Midrange
FOCUS	Midrange
SCALE	Approx. 90° to the right from the midrange

⑤ Connecting the power cord

Using the accessory power cord, connect the AC power supply and this instrument. (See Fig. 4-1-1.)

Figure 4-1-1. Switches, etc. to Be Operated on Rear Panel

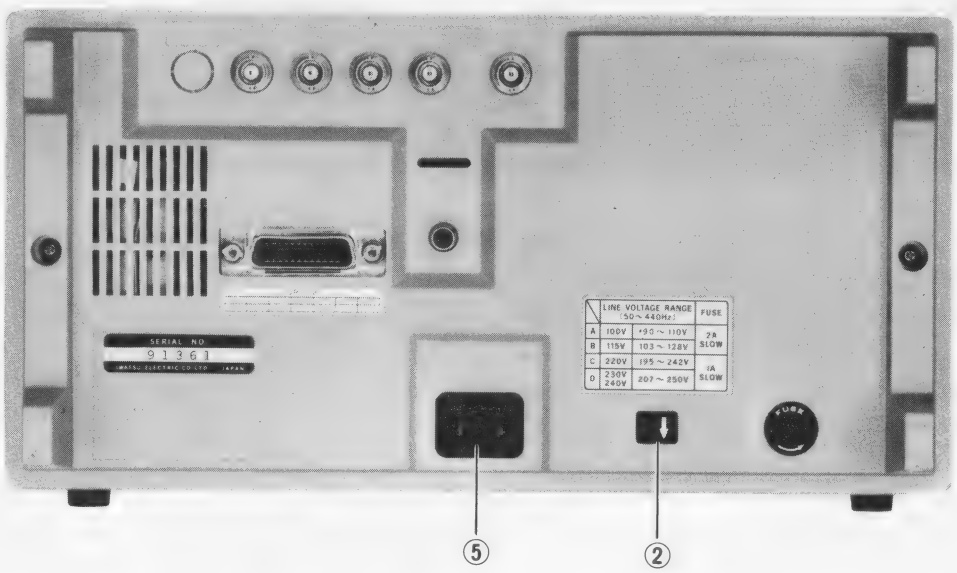
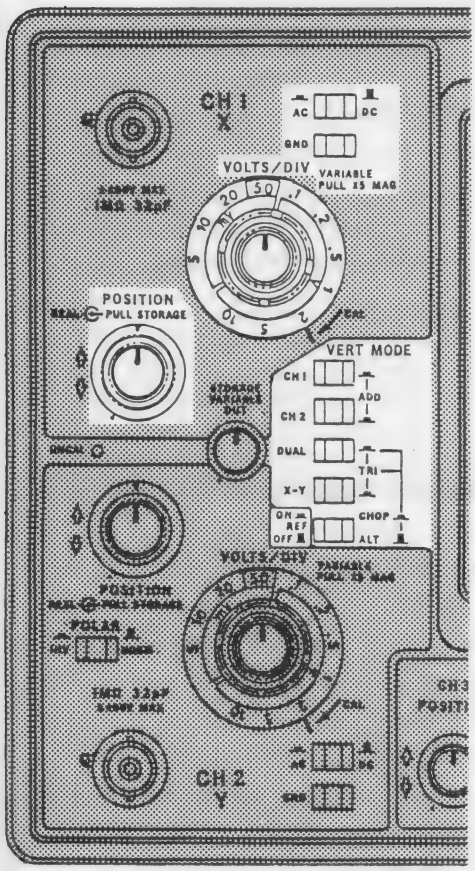
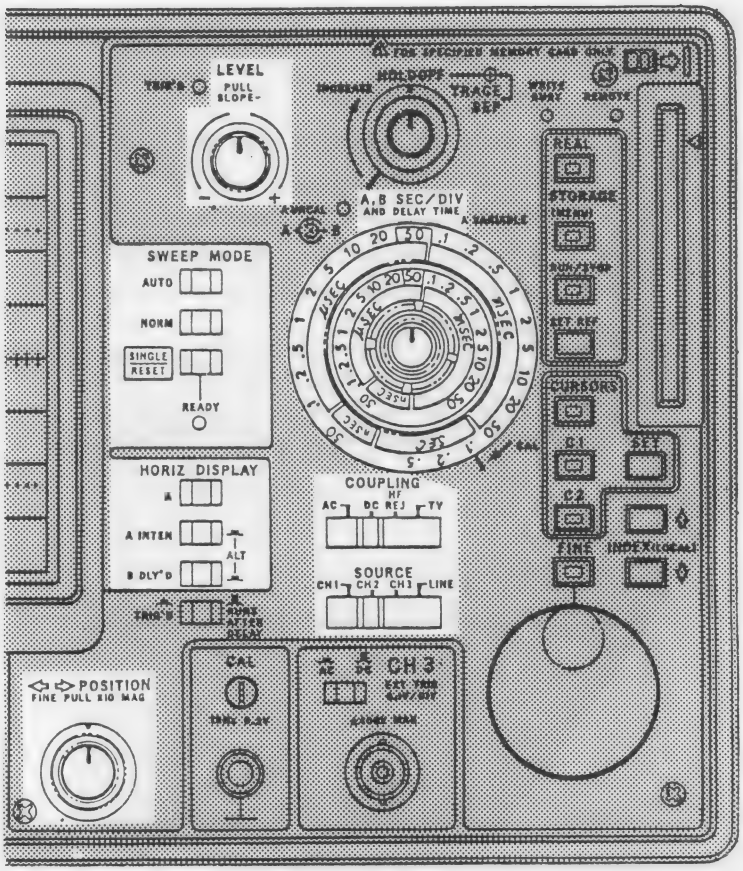


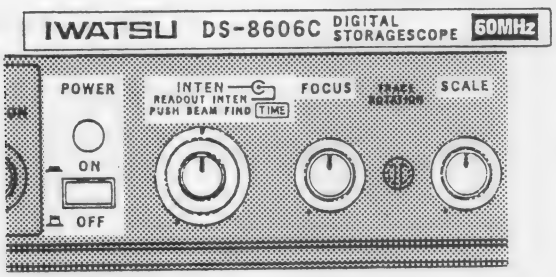
Figure 4-1-2. Switches, etc. to Be Operated on Front Panel

Vertical Deflection System

Triggering and Horizontal Deflection System







Power Supply and CRT Control

4-2 POWER-ON AND CRT CONTROL

Procedure

① Turning on the power

Turn on the POWER switch. The POWER indicator lights up.

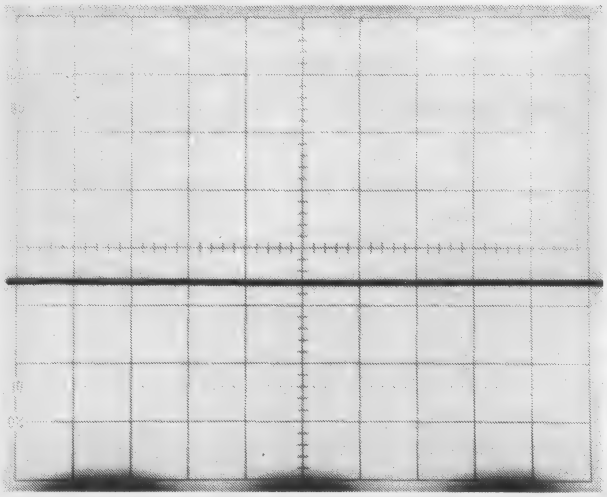
② Adjusting INTEN (outer knob)

About 30 seconds after turning on the POWER switch, the trace appears near the center of the screen.

When it does not appear, turn this knob clockwise.

Adjust trace brightness so that it can be easily seen.

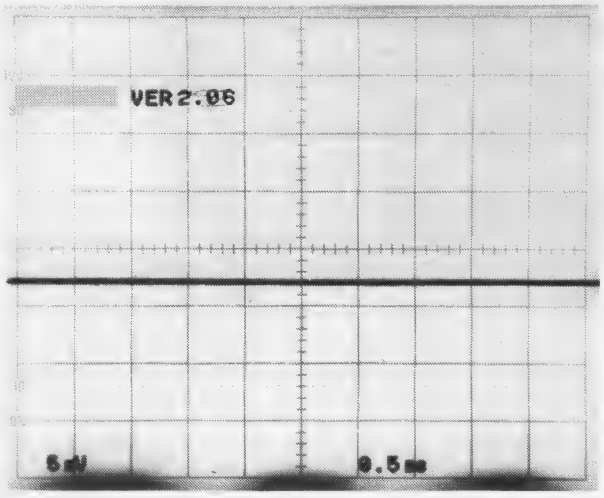
Turning clockwise increases brightness and turning counterclockwise decreases it.



③ Adjusting READOUT INTEN (inner knob)

Turning READOUT INTEN makes a readout display appear. Adjust readout display brightness so that it can be easily seen.

Turning clockwise increases brightness and turning counterclockwise decreases it.

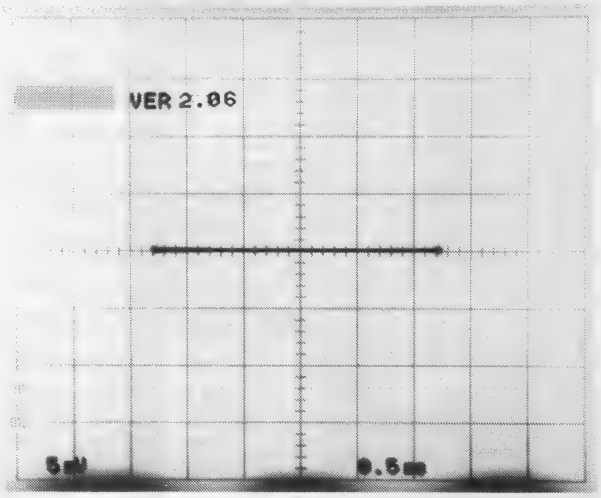


[Note] A version value may be changed.

④ Checking PUSH BEAM FIND

This is used when looking for a trace position.

If you press this knob, the trace outside the screen will appear within the screen. If pressed in the state of ③ , the following screen will appear.



⑤ Adjusting FOCUS

Adjust the focus to the best condition.

⑥ Adjusting SCALE

Adjust the scale to easy-to-view brightness. Turning clockwise increases brightness and turning counterclockwise decreases it.

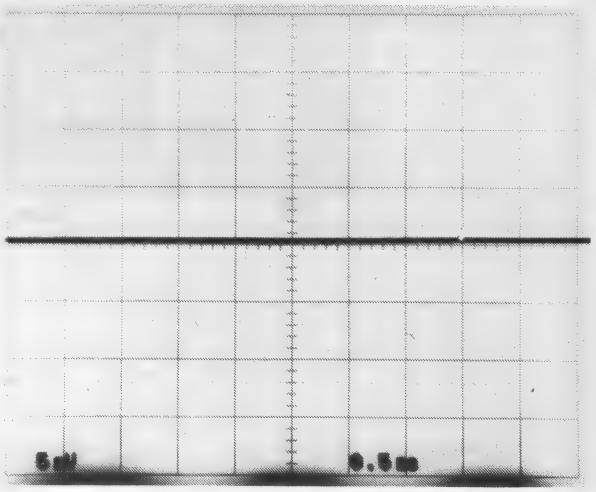
⑦ ↕ REAL POSITION

Adjust a vertical position. Turning clockwise moves the vertical position upward and turning counterclockwise moves it downward.

⑧ Adjusting TRACE POSITION

Using ↕ REAL POSITION, set the trace to the center of the screen and adjust trace parallelism to the horizontal scale of the screen.

Due to an effect of earth magnetism, the parallelism may slightly differ depending on an installation position of this instrument.



4-3 OUTPUTTING THE CAL WAVEFORM

① Connecting the Probe

Using an accessory probe, connect CAL output to CH1 INPUT. A CAL waveform with an amplitude of 6 div appears on the screen.

Use of the accessory probe automatically displays the deflection factor of the CH1/CH2 vertical axis at a magnification of 10 times, thus allowing direct reading of displays of the deflection factor.

② Using an accessory screwdriver, correct a probe waveform.

Figure 4-3-1. Connecting the Probe

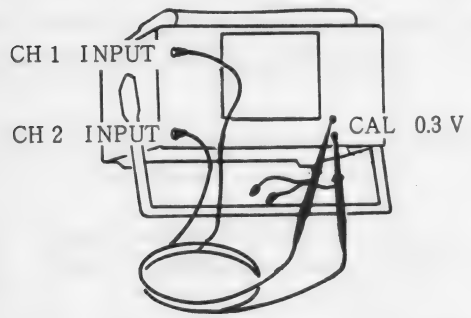
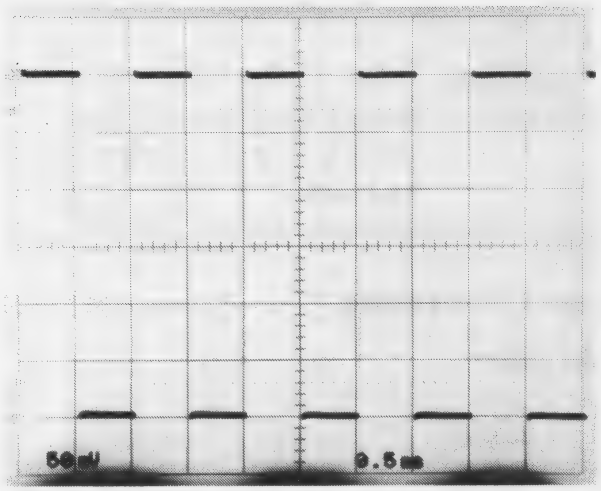


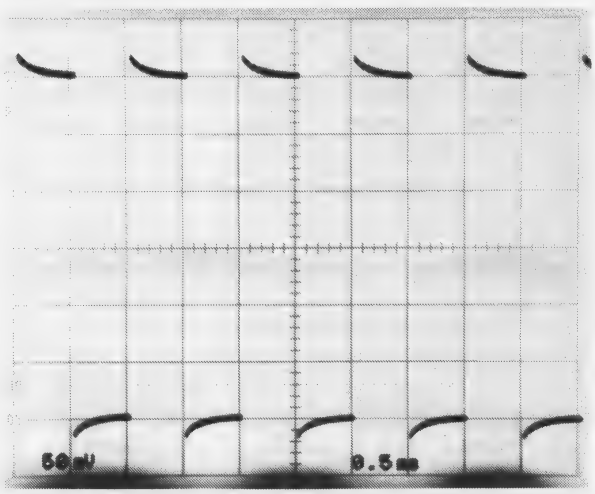
Figure 4-3-2. Correcting the Probe

a) Correct waveform

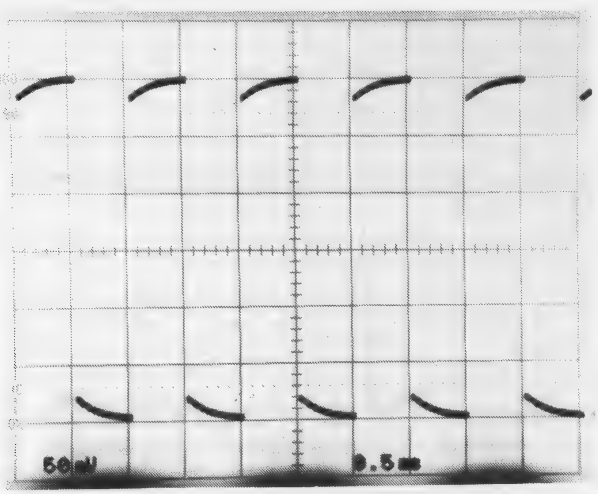


b) Incorrect waveform

Over compensation



Under compensation



4-4 VERTICAL DEFLECTION SYSTEM

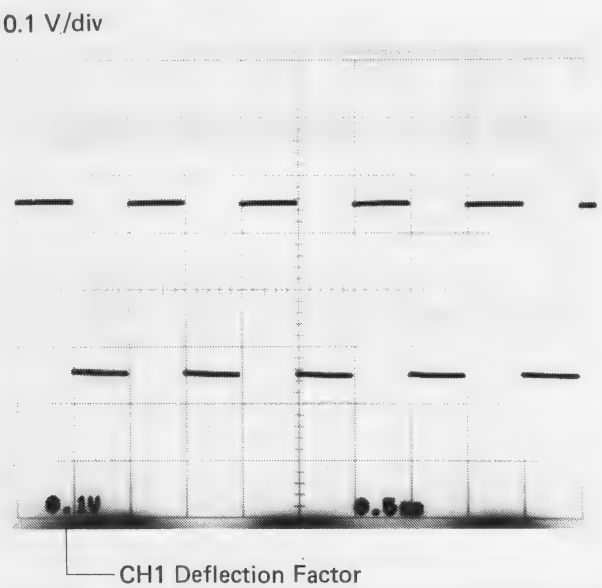
CH1·CH2·CH3

① VOLTS/DIV

CH1, CH2 : Selects a vertical deflection factor. Selects a range in accordance with an input signal.

CH3 : Fixed at 0.1 V.

Figure 4-4-1. VOLTS/DIV

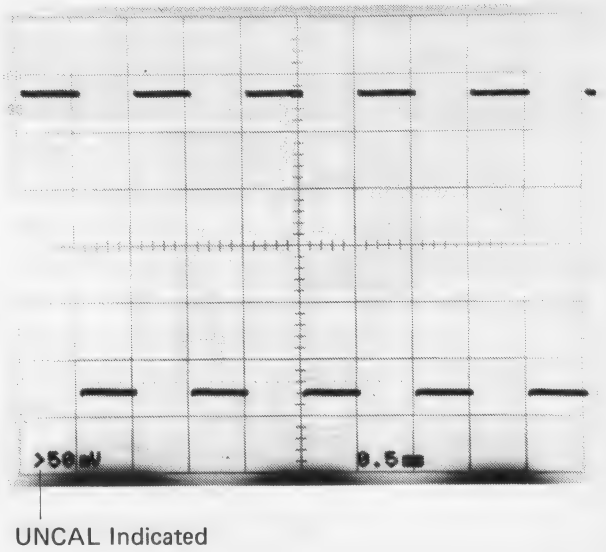


② VARIABLE (PULL x MAG 5)

VARIABLE : VOLTS/DIV fine regulator. Turning fully counterclockwise sets VOLTS/DIV to 1/2.5 or less.

Use of VARIABLE lights up the UNCAL LED on the panel and provides a display with an uncalibrated value mark " > " on the screen.

Figure 4-4-2. VARIABLE of VOLTS/DIV



(PULL x 5 MAG): Pulling this knob to this side enlarges 5 times the waveform on the screen in the vertical direction.

③ ↕ POSITION

Adjusts the vertical position of the trace.

Turning clockwise moves the position upward and turning counterclockwise moves it downward.

④ Input coupling method (AC-DC, GND) selection

DC: All frequency components of the input signal are passed to the vertical input amplifier.

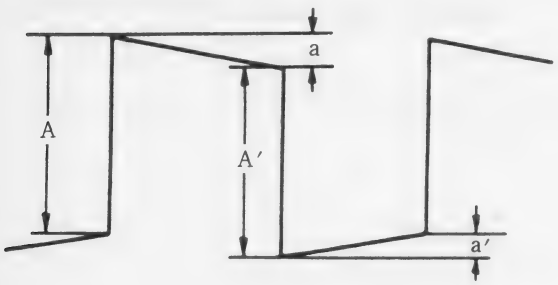
AC: Signals are capacitively coupled to the vertical deflection system. The DC component of the input signal is blocked.

Even if a deflection factor is higher, an AC signal waveform is not moved outside the screen by DC thus enabling observation with high amplitude on the CRT screen.

However, when observing a signal with a low repetition frequency with AC coupling, a sag appears in case of a square wave (refer to Fig. 4-4-3), and if it is a sine wave, it will appear, being attenuated against an actual amplitude. This attenuation is approximately –3 dB at 4 Hz.

GND (Ground): The input of the vertical amplifier is grounded to provide a ground reference.

Figure 4-4-3. Definition of Sag



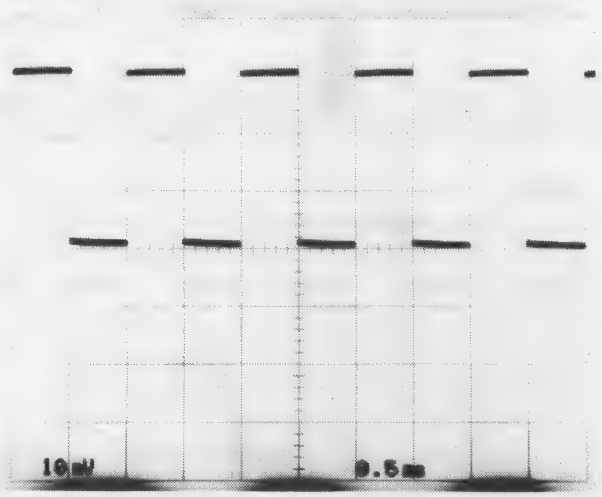
$$\text{Sag} = \frac{a}{A} \left(\text{or } \frac{a'}{A'}\right) \times 100\%$$

taking the bigger value of either $\frac{a}{A}$ or $\frac{a'}{A'}$

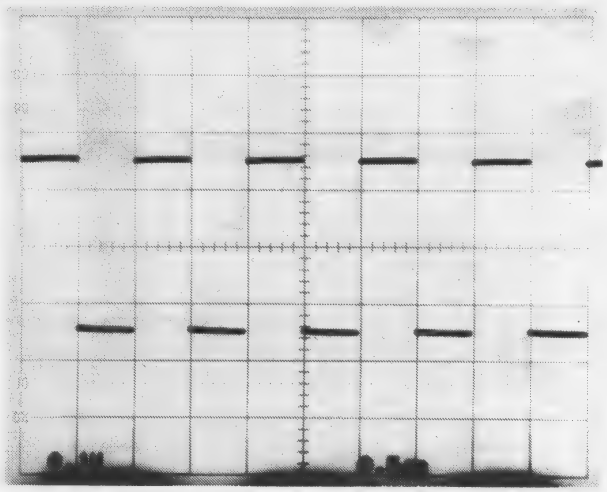
(according to Electronic Machinery Industry Assoc. MEA-27)

Figure 4-4-4. Input Coupling

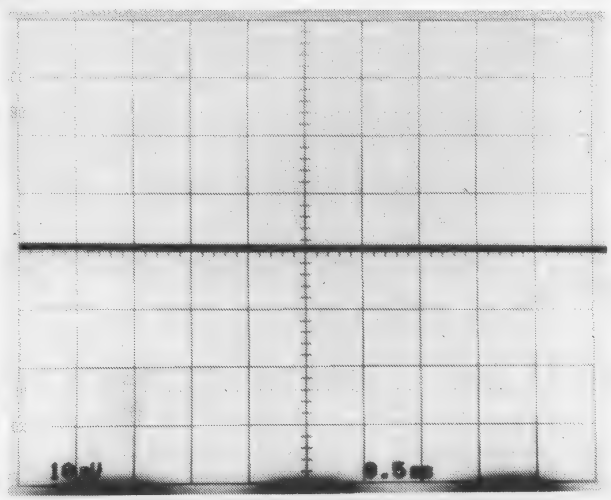
DC Coupling



AC Coupling



GND

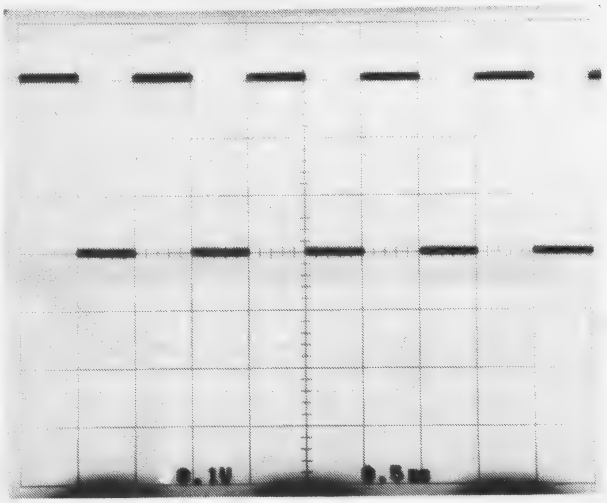


⑤ POLAR

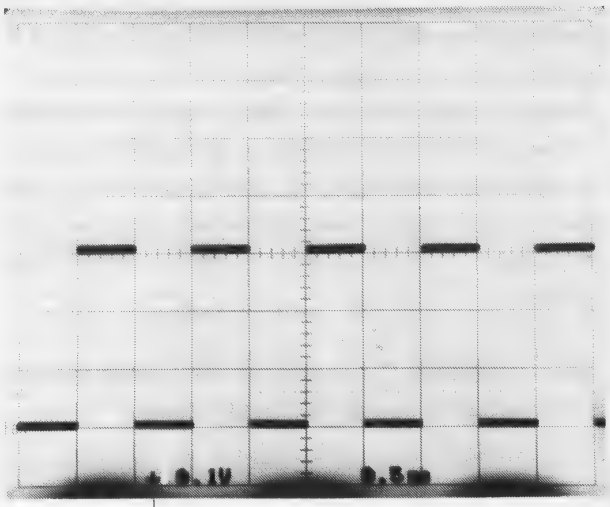
If set to INV, CH2 display is inverted.

Figure 4-4-5. CH2 POLAR

NORM



INV



Polarity: INV Indication

⑥ MODE

Enables setting of 1-PHENOMENON, 2-PHENOMENON, ADD (sum or difference), X-Y and reference memory display in STRAGE modes.

- REAL and STORAGE mode.

  1-PHENOMENON (CH1 or CH2): Press either CH1 or CH2.

  2-PHENOMENON (CH1 and CH2): Press DUAL, and then, select ALT/CHOP.

- REAL mode only.

  3-PHENOMENON (CH1, CH2 and CH3): Press DUAL and X-Y simultaneously, and then, select ALT/CHOP.

  SUM (CH1 + CH2): Press CH1 and CH2 simultaneously.

  DIFFERENCE (CH1 – CH2): Press CH1 and CH2 simultaneously, and then, set CH2 POLAR to INV.

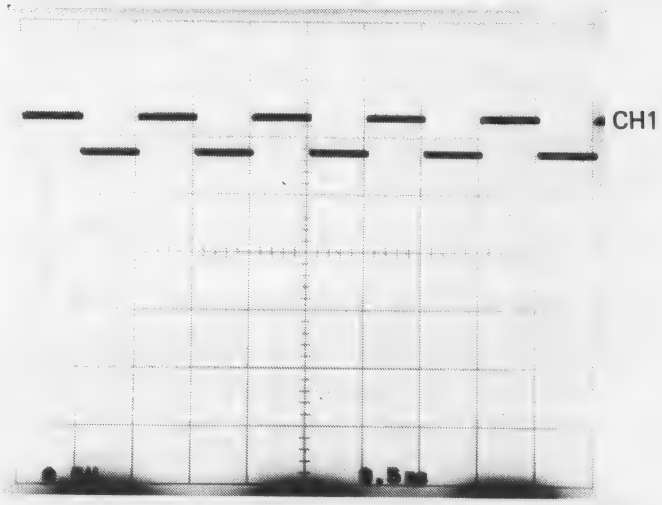
  X-Y (X = CH1, Y = CH2): Press X-Y. Adjust VERT POS with CH2 POSITION.

- STORAGE mode only

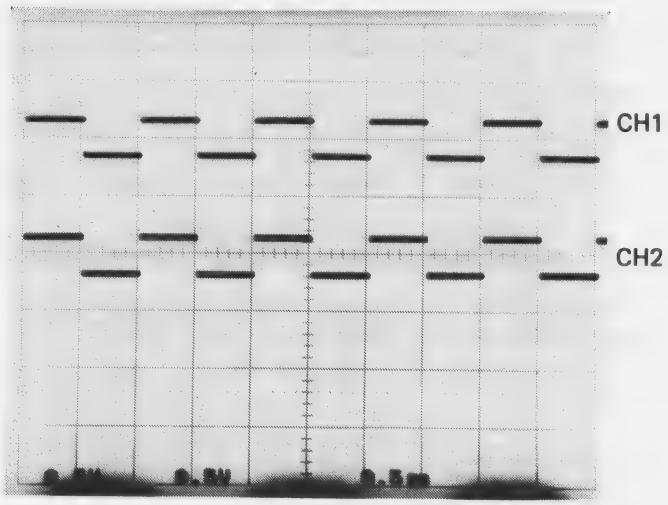
  REF: Turns on/off the reference memory display in the STORAGE mode. For details, see "4-7 STORAGE Modes".

Figure 4-4-6. MODE I

1-PHENOMENON (CH1)



2-PHENOMENON (CH1 and CH2)



3-PHENOMENON (CH1, CH2 and CH3)

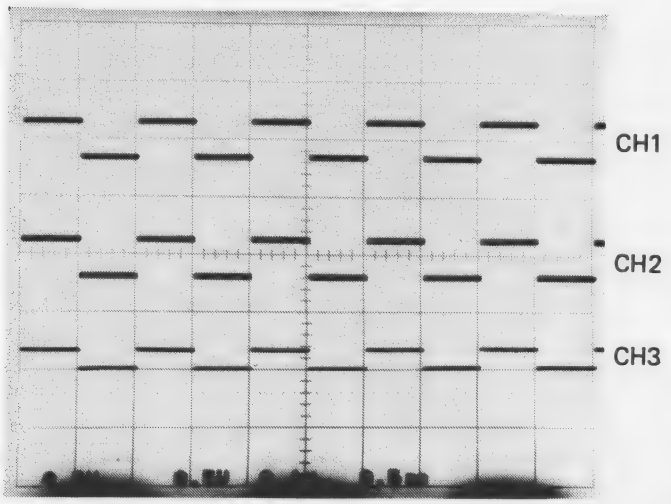


Figure 4-4-7. MODE II (ADD)

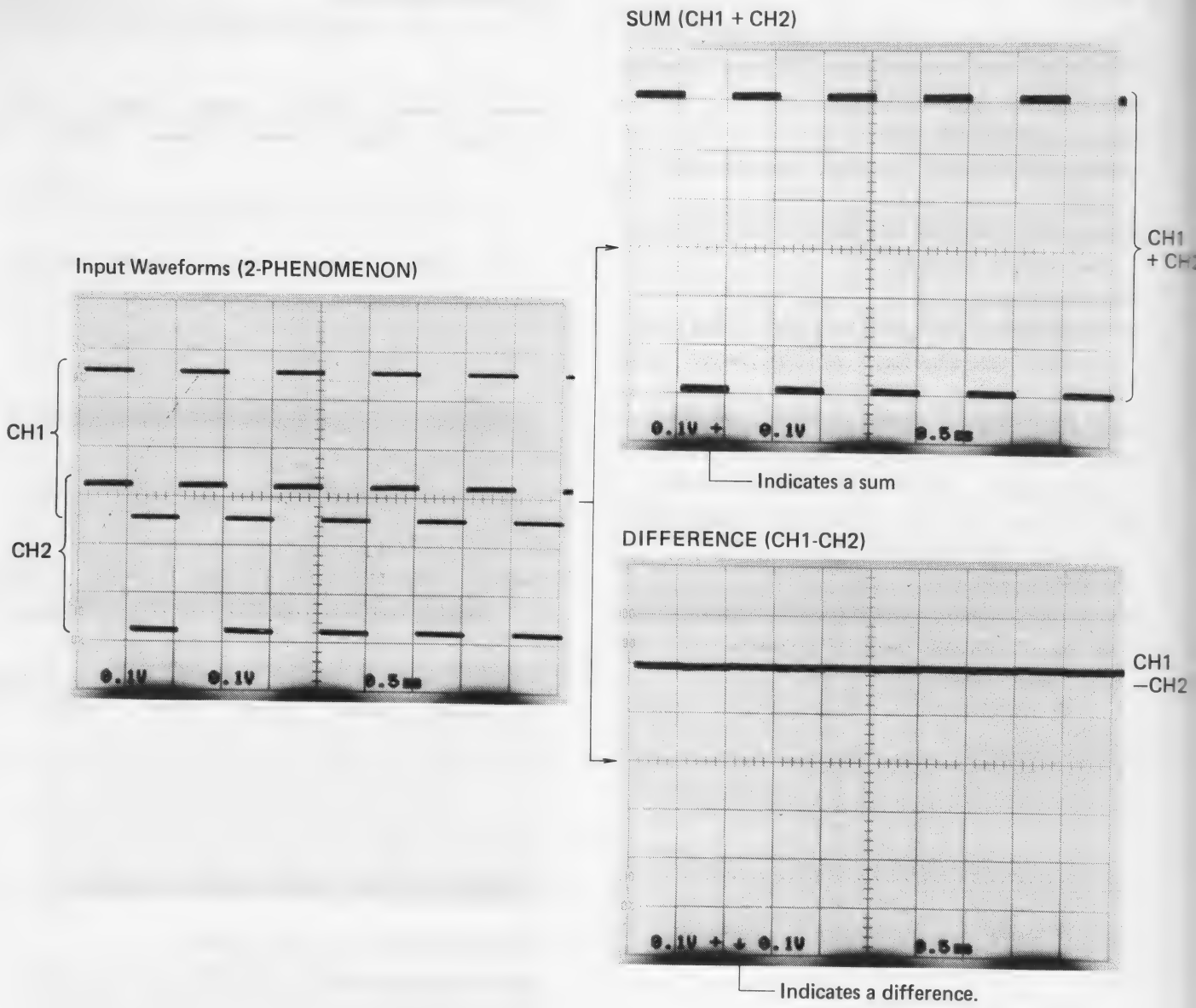


Figure 4-4-8. MODE III (X-Y)

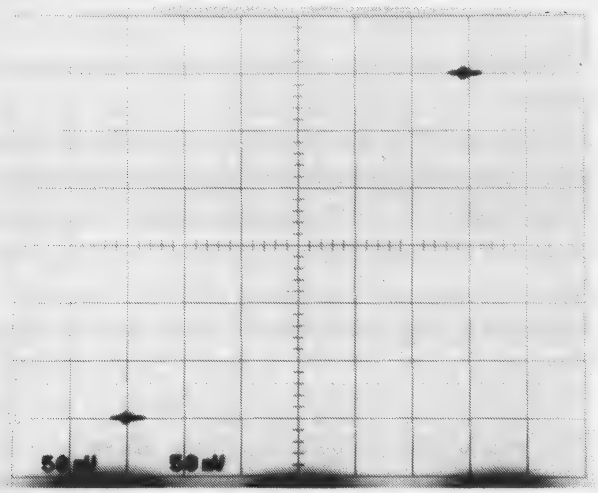


Figure 4-4-9. X-Y Measurement (I)

Phase Difference and Frequency Ratio upon Input of Sine Wave

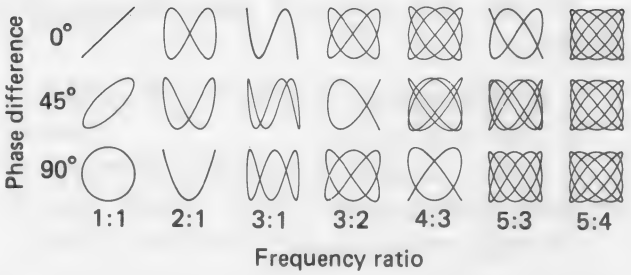
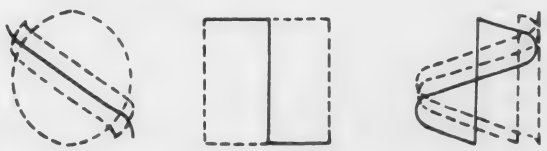


Figure 4-4-10. X-Y Measurement (II)



Sine Wave and Triangular Wave 1 : 1

Sine Wave and Square Wave 1 : 1

Sine Wave and Saw-tooth Wave 1 : 1

4-5 TRIGGERING

Operation to make a measured signal stand still on the screen and draw it is called "triggering". The following describes operation for triggering.

To trigger, the following 5 operational steps are required:

1. SOURCE selection
2. COUPLING selection
3. SLOPE selection
4. LEVEL adjustment
5. HOLDOFF adjustment

① SOURCE selection

In order to trigger, apply to the trigger circuit an input signal itself or a signal, which has constant time relations (multiple, divisor) with the input signal (they are called trigger signals) to actuate the trigger circuit and generate trigger pulses, and drive the sweep circuit with those trigger pulses.

Internal Trigger (CH1, CH2, CH3)

A method, which applies the input signal applied to INPUT to the trigger circuit halfway the vertical deflection system, is called internal trigger.

Setting SOURCE to either CH1, CH2 or CH3 provides internal trigger. In internal trigger, the input signal is internally connected to the internal circuit halfway the vertical deflection system. So, if the input signal is applied to INPUT, even the input signal with a low voltage will be amplified to an appropriate voltage and automatically guided to the trigger circuit.

Therefore, operation is simple and the output impedance of a trigger signal source is not reduced as it is in case of external trigger. Normally, measurement by internal trigger is convenient, taking these advantages into account.

Measuring two input signals whose frequencies are equal:

When measuring two input signals whose frequencies are equal, triggering can be done more stably by switching to the channel to which the input signal with a higher voltage and less noises has been applied.

Measuring two input signals whose frequencies are different:

It is necessary to switch to the channel to which the input signal with a lower frequency has been applied. If switched the other way around, a waveform with the lower frequency cannot be triggered.

External Trigger (EXT TRIG)

A method, which externally and directly applies an input signal itself or a signal having constant time relations with the input signal to the trigger circuit, is called external trigger.

This DS-8606C is intended for CH3, External Trigger, and is capable of displaying the signal as CH3 entered into EXT TRIG as well on the screen.

Line Trigger (LINE)

A method, which divides the AC supply voltage and applies it to the trigger circuit, is called line trigger.

Setting SOURCE to LINE provides line trigger.

When measuring a line frequency or its higher harmonics, since line (power supply) trigger divides the AC supply voltage to generate a trigger signal, triggering can be stably done without separately applying the trigger signal.

② **COUPLING selection**

Selects the coupling method (filter) of the trigger circuit. This is for stably triggering and displaying on the screen a signal overlapped by AC, DC and higher harmonic noises or a TV signal.

AC: The trigger circuit assumes AC coupling. Triggering is done by only the AC component of the trigger signal. Since the DC component of the trigger signal is cut off, triggering is enabled regardless of the DC component of the trigger signal.

Generally, this AC coupling is convenient. However, triggering becomes difficult when a trigger signal frequency is 100 Hz or less.

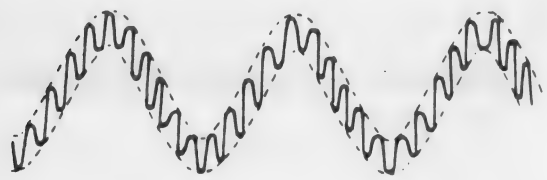
DC: The trigger circuit assumes DC coupling which allows triggering from DC. However, when DC overlaps the trigger signal, no triggering is applied if its DC voltage is outside a LEVEL setting range.

HF REJ: The trigger circuit assumes coupling through a low-pass filter. A high-frequency trigger signal (about 10 kHz or more) or high-frequency noises overlapping the trigger signal are attenuated, thus allowing only the low-frequency component to pass.

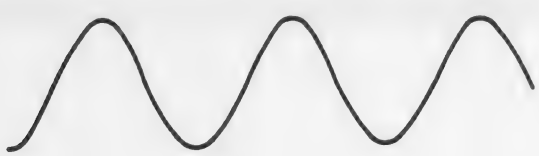
TV: The trigger circuit assumes coupling which stably triggers a TV signal. (See Fig. 4-5-2.)

Figure 4-5-1. HF REJ

a. Trigger Signal Overlapped by High-frequency Noises



b. Trigger Signal with High-frequency Noises Eliminated by HF REJ



• **Observing the TV waveforms of V Trigger Signal**

Procedure

① Set HORIZ DISPLAY to A.

② Set VOLTS/DIV so that the trigger signal will deflect by 1 division or more.

③ Set Horizontal MODE to either AUTO or NORM.

④ For SLOPE, set it to "–" when the trigger signal component is on the lower side, and to "+" when it is on the upper one.

• **Observing the TV waveforms of H Trigger Signal**

Procedure

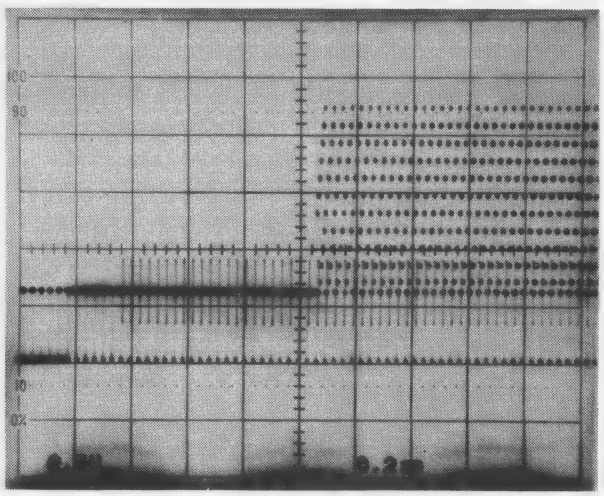
① Set HORIZ DISPLAY to A INTEN.

② Using DELAY TIME (rotary encoder), select the position where the H trigger signal can be observed.

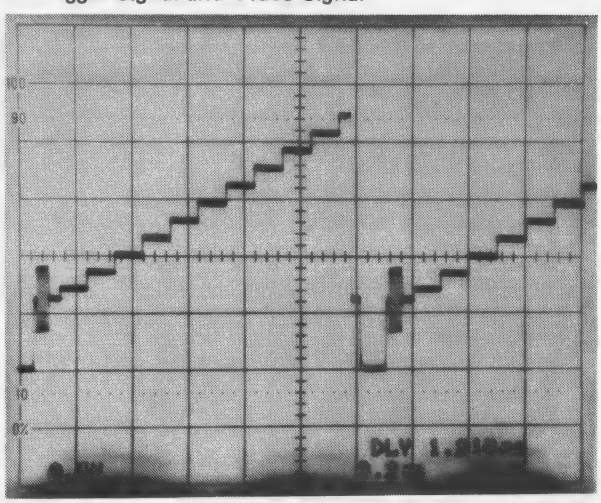
③ Set HORIZ DISPLAY to B DLY'D and select a magnification rate with B SEC/DIV.

Figure 4-5-2. TV Signal Observation

a) V Trigger Signal and Video Signal



b) H Trigger Signal and Video Signal



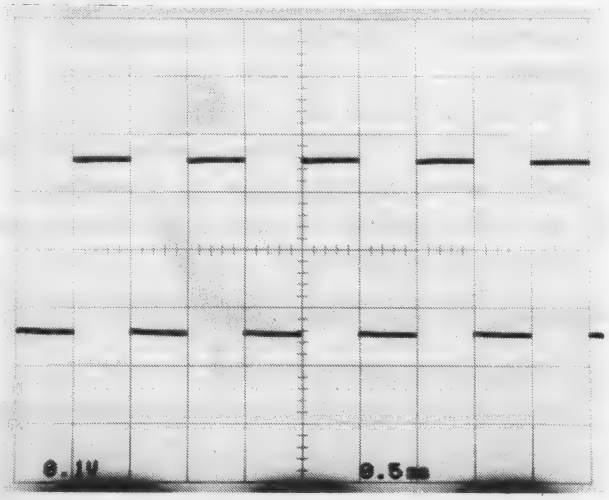
③ SLOPE selection

Select slope (+ or −) of the trigger signal.

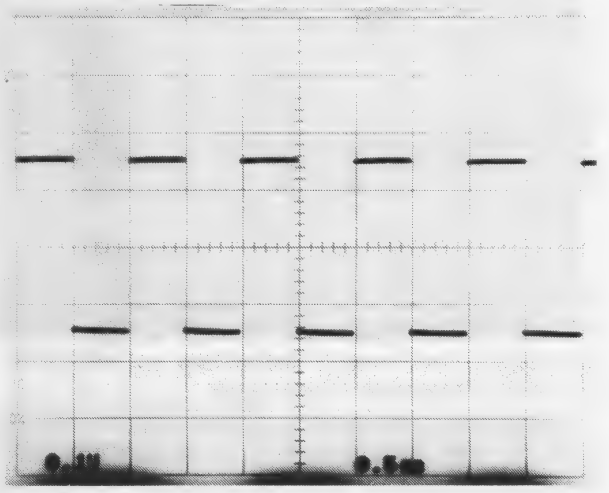
When triggering with the positive slope, press the LEVEL knob, and when triggering with the negative slope, pull the knob to this side.

Figure 4-5-3. Slopes

Positive (+) Slope



Negative (−) Slope



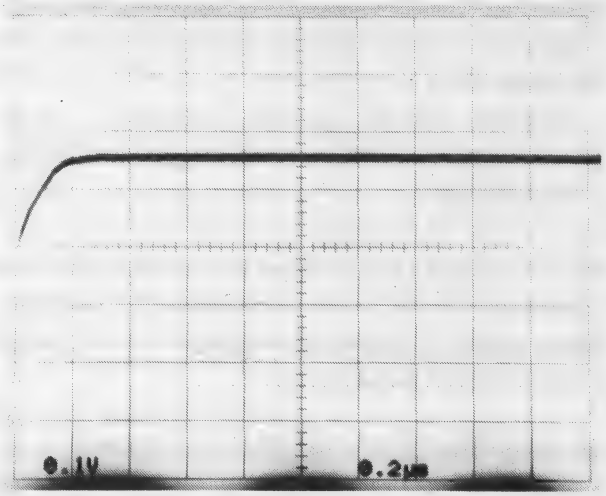
④ LEVEL adjustment

Adjust a trigger level.

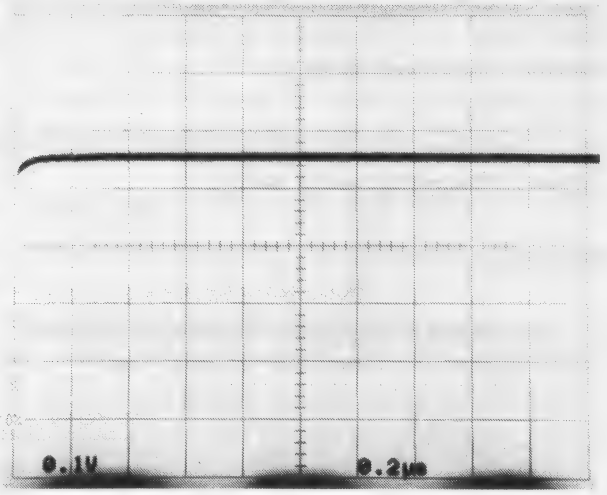
If triggering is properly done, the A TRIG'D indicator will light up.

Figure 4-5-4. Level Adjustment (For "+" Slope)

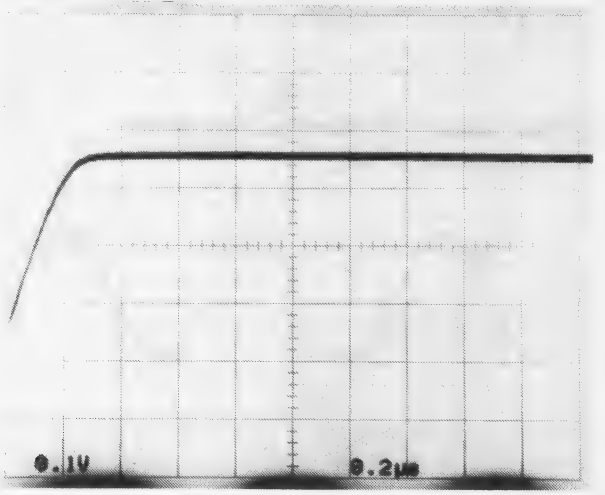
Midrange



Clockwise



Counterclockwise



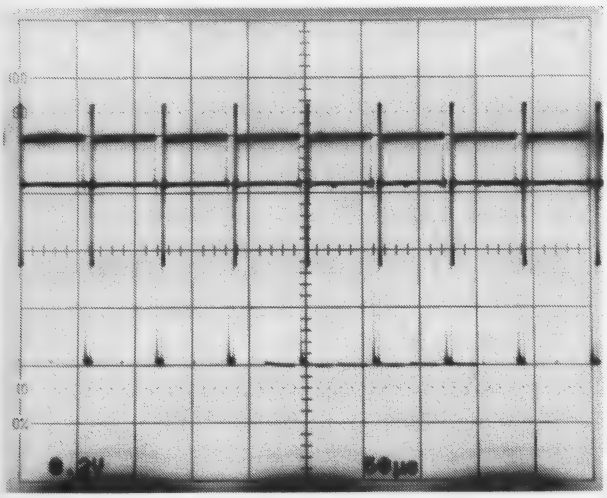
⑤ HOLDOFF adjustment

When observing a waveform of a complicated pulse sequence, the waveform to be measured may be doubled, even if triggering is obtained.

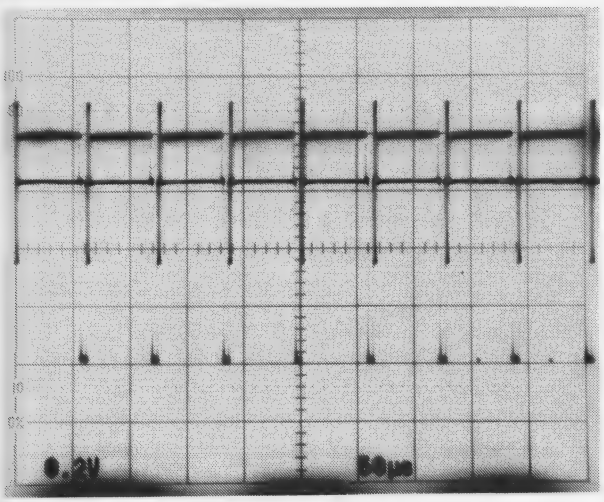
In this case, turn HOLDOFF in the INCREASE direction (clockwise) from its leftmost position to change a sweep cycle, and make adjustment so that the sweep will always start in a signal's basic cycle. Thus, the waveform is drawn in an easy-to-observe condition.

Figure 4-5-5. HOLDOFF

Before HOLDOFF Adjustment (Fully Turned to Left)



After HOLDOFF Adjustment



4-6 HORIZONTAL DEFLECTION SYSTEM

① MODE

Selects a sweep mode.

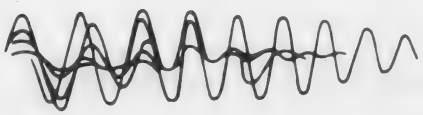
AUTO: Sweep free runs in the absence of a triggering signal. The triggering level changes only when the LEVEL control is adjusted to a new position.

NORM: Sweep is initiated when an adequate trigger signal is applied. When the trigger level is out of the trigger level range or when there is no trigger signal, sweeping stops.

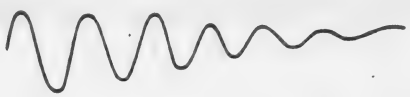
SINGLE: Sweep is initiated one time when an adequate trigger is applied. Sweep cannot be initiated again until the sweep logic is reset by pressing the SINGLE RESET .

Figure 4-6-1. Examples of Repetitive Sweep and Single

a. Repetitive Sweep



b. Single Sweep

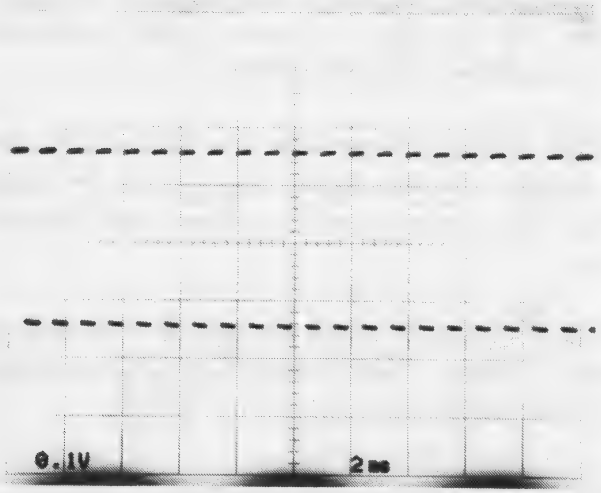


② A SEC/DIV

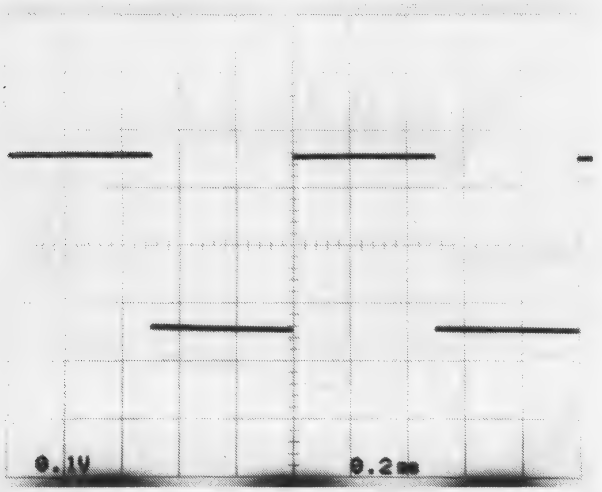
Changes a sweep time for A SWEEP. Select a range in accordance with an input signal in a 1-2-5 step sequence.

Figure 4-6-2. SEC/DIV

Delaying the Sweep Time



Speeding up the Sweep Time

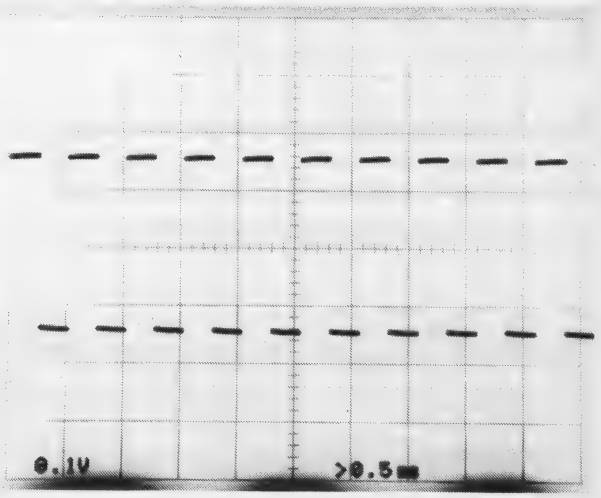


③ A VARIABLE

Fully turning this counterclockwise sets 1/2.5 or less.

Use of VARIABLE provides a display with an uncalibrated mark " > ".

Figure 4-6-3. VARIABLE of SEC/DIV



④ ↔ **POSITION and FINE**

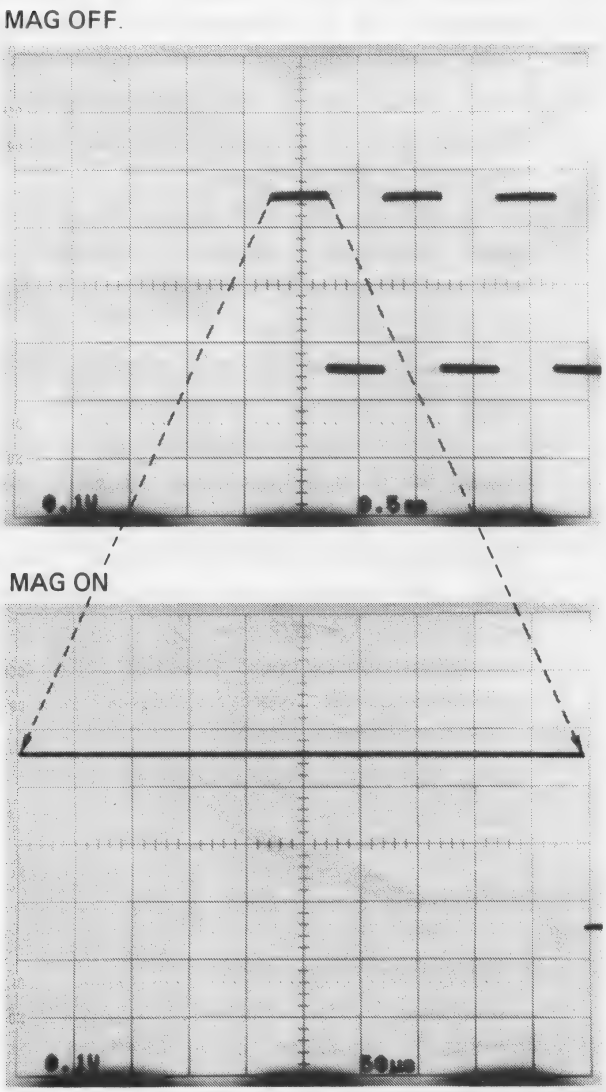
Adjusts a horizontal position.

↔ POSITION is for coarse adjustment and FINE is for fine adjustment.

⑤ **X10 MAG**

A waveform is enlarged from the center of the screen to the right and left by pulling to this side the horizontal position fine adjustment knob.

Figure 4-6-4. SEC/DIV Enlargement (X10 MAG)



⑥ HORIZ DISPLAY

A : Displays only the A Sweep. The horizontal deflection rate are determined by the setting of the A TIME/DIV switch.

A INTEN: Prepare for the delay sweep (B DLY'D). Displays the B-Sweeped portion that is modified in brightness on the A Sweep.

B DLY'D : Displays only the B Sweep. The B Sweep rate is determined by the setting of the B TIME/DIV switch, and the delay time is determined by DELAY TIME control.

ALT : Alternates the display between the A INTEN and B DLY'D sweeps. The REAL mode only.

TRIG'D : B Sweep runs when triggered by a triggering signal after the established delay time has elapsed, provided the A Sweep has not terminated. Since the B Sweep runs at the time the triggering signal occurs, the display is stable, even with jittering signals; but the actual delay time is greater than the delay-time setting. Therefore, the CRT readout shows " > " mark in this mode.

RUNS AFTER DELAY (Continuous delay): The B Sweep runs immediately after the established delay time has elapsed.

Setting the Delay Time:

If you set HORIZ DISPLAY to A INTEN, you can set the delay time with the rotary encoder.

When CURSORS has been already set, set the DELAY TIME according to the Guide Menu. (Refer to 4-8-10 DELAY TIME).

Fine adjustment is available when the FINE LED is lit up.

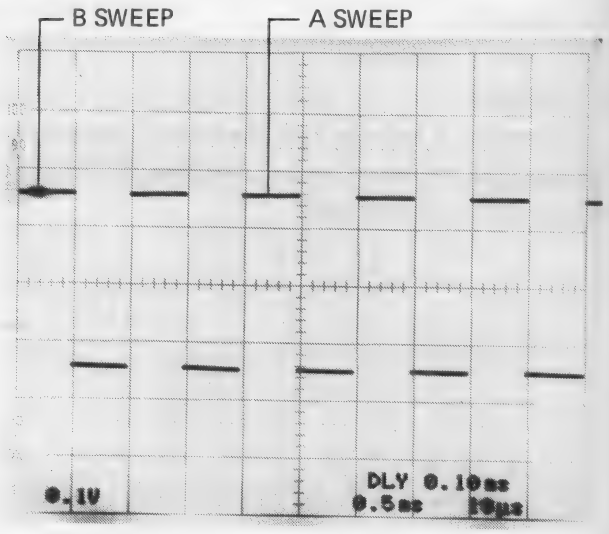
On the other hand, if you set it to B DLY'D. a point some time behind a sweep start point is enlarged and displayed.

A delay sweep is determined by A SEC/DIV and DELAY TIME, and a magnification by a ratio of a SEC/DIV and B SEC/DIV.

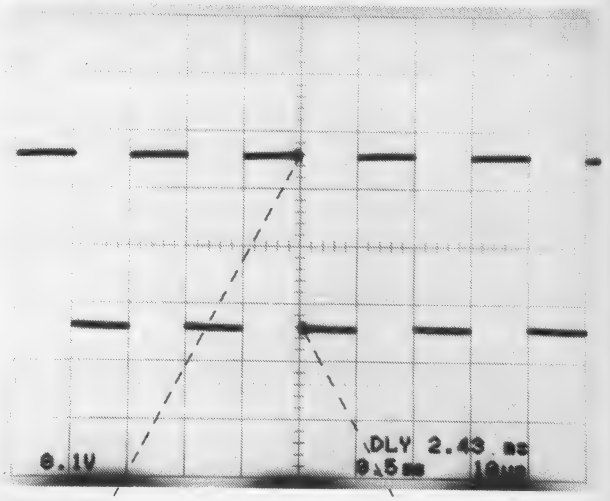
$$\text{Magnification} = \frac{\text{A SEC/DIV}}{\text{B SEC/DIV}}$$

Figure 4-6-5. HORIZ DISPLAY I (RUNS AFTER DELAY)

a. A INTEN



b. A INTEN (Continued)
Setting B SWEEP to Enlarging Position



c. B DLY'D

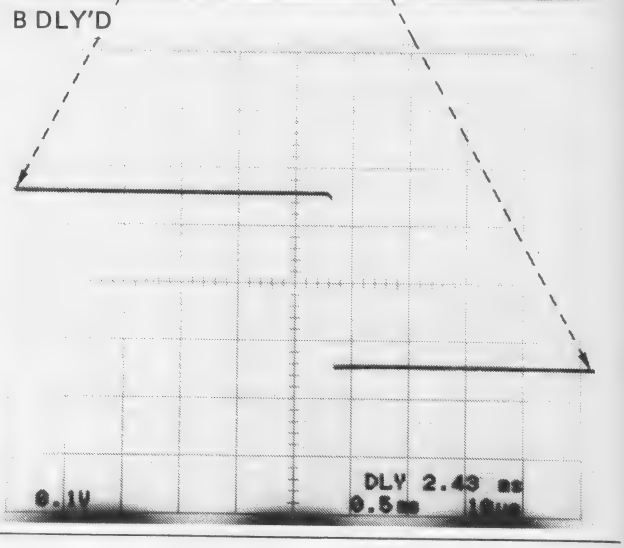
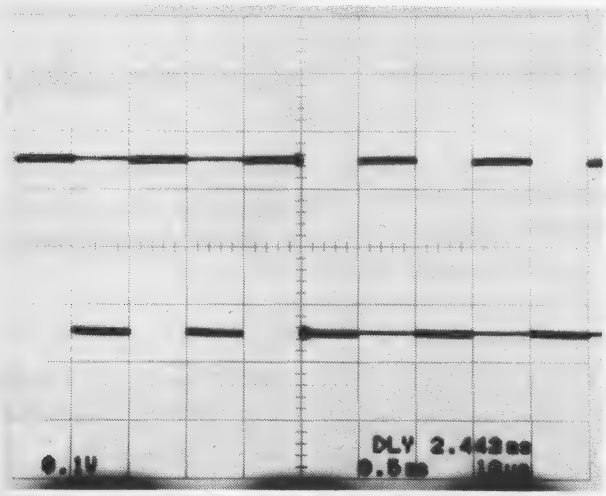


Figure 4-6-6. HORIZ DISPLAY I (Continued)

a. ALT (A INTEN and B DLY'D)



b. ALT (Continued)
Raising B DLY'D Position with TRACE SEP

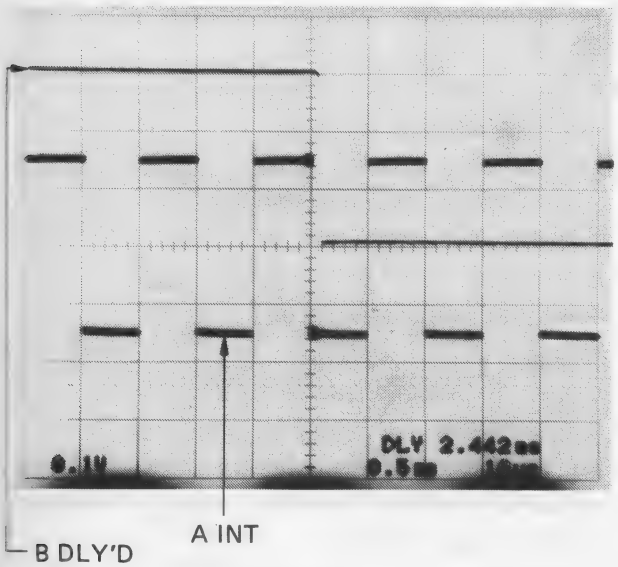
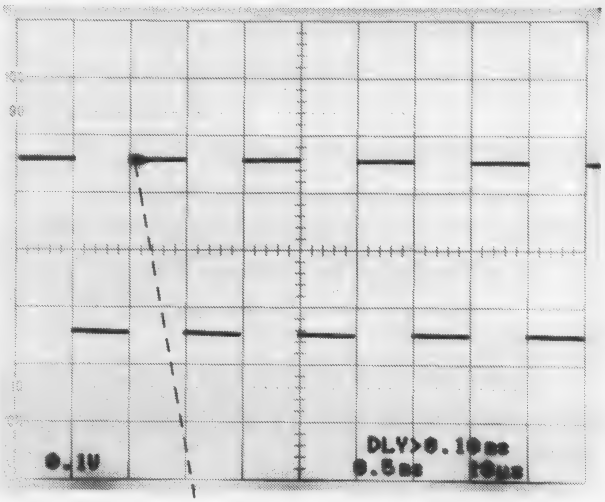
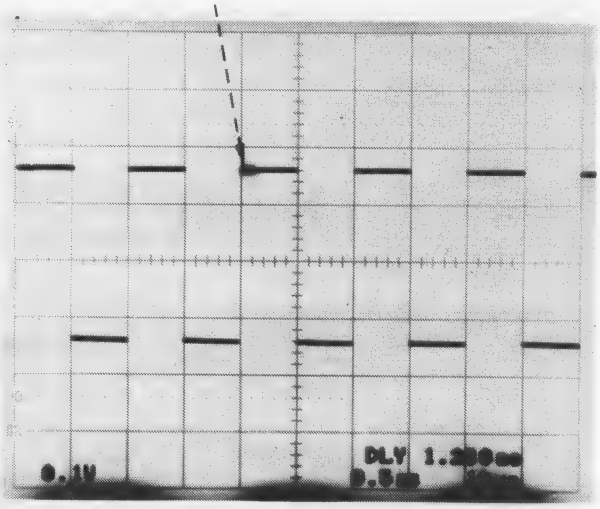


Figure 4-6-7. HORIZ DISPLAY II (TRIG'D)

a. A INTEN
Initial Setting



b. A INTEN (Continued)



Turning DELAY TIME (rotary encoder) clockwise makes the B sweep jump from the position in Fig. a to that in Fig. b.

4-7 STORAGE Modes

Every time [STORAGE] is pressed, the screen is changed over as follows:

When DS-504 (GP-IB) is mounted;

REAL Screen → STORAGE Measurement Screen → STORAGE Character Screen → Memory Card Character Screen

When DS-505 (RS-232C) is mounted;

REAL Screen → STORAGE Measurement Screen → STORAGE Character Screen → Memory Card Character Screen and RS-232C Character Screen

Measurement Screen

If RUN/STOP is set to RUN (LED is lit up), the WRITE BUSY indicator will blink and writing and reading will be repeated.

When desiring to leave a written waveform on the screen as it is, press RUN/STOP to set the STOP mode (LED is lit off).

The STORAGE mode allows 4-phenomenon observation by using 4 display memories; CH1 memory, CH2 memory and 2 REF memories.

Character Screen

On the Character screen, select a mode and measuring conditions, using the Index keys and the rotary encoder.

Next, pressing [RUN/STOP] starts a measurement.

Pressing [STORAGE] displays the Waveform screen in the STOP mode.

The following describes the Character screen and its operating method:

Character Screen	Operating Method
? STORAGE MODE * NORMAL / AVERAGE / PEAK CH HOLD / ROLL — Mode COUNT REPEAT ON(0SEC) DATA LENGTH 1KW TIME BASE INT EQU-SAMPLING OFF INTERPOLATION OFF — Measuring Conditions SAVE CH1 DISPLAY CH1 INPUT CH2 INPUT — Save and Display of Waveform OUTPUT OFF — Hard copy GP-IB ADDRESS=5;LF — GP-IB [Note] This screen is displayed when DS-504 (GP-IB) is mounted.	• Index keys ([⇧] , [⇩]) Select the item you want to set. Pressing [⇧] moves a mark "?" upward, and [⇩] moves it downward. • Rotary encoder Set the items specified with the mark "?" (mode, measuring conditions, save and display of weveform, waveform output, GP-IB). Mode setting . . . . . Specify with "*". Other setting . . . . . A screen display changes. For details, see "4-7-5" to "4-7-14". • [RUN/STOP] key*1 Every time [RUN/STOP] is pressed, the LED blinks. When the LED is lit up, measurement starts, and when the LED lights off, measurement stops.

*1 When [STOP] ispressed while the waveform is being taken in;

STORAGE MODE / DATA LENGTH	NORM	AVERAGE PEAK CH HOLD
1 kw	1. Takes in completely the waveform of one frame. 2. Displays it and stops.	1. Takes in completely the waveform of one frame. 2. Calculates. 3. Displays it and stops.
16 kw	1. Discontinues taking in the moment that [STOP] is pressed. 2. Displays the waveform which has taken in and stops (Halfway waveform display)	1. Discontinues taking the moment that [STOP] is pressed. 2. Calculates datum which have taken in. 3. Displays the waveform and stops.

[Note] When [STOP] is pressed at the data length of 16 kw, taking the waveform is discontinued.
To stop the waveform after a frame is completely taken in, make a best use of REPEAT function of the menu (refer to '4-7-5 REPEAT'.)

Parameter of the STORAGE mode

[?] STORAGE MODE ⊡ NORMAL
□ AVERAGE
□ PEAK CH HOLD
□ ROLL

- □ COUNT ..... 2, 4, 8, 16, 32, 64, 128, 256, ∞
- □ REPEAT ..... OFF, ON (O SEC), ON (1 SEC) ON (2 SEC)
- □ DATA LENGTH 1KW, 16KW
- □ TIME BASE ..... INT, EXT
- □ EQU-SAMPLING ..... ON, OFF
- □ INTERPOLATION ..... OFF, LINEAR, SINE
- □ SAVE CH1, CH2

DISPLAY
- □ CH1 ..... INPUT, SAVED
- □ CH2 ..... INPUT, SAVED
- □ OUTPUT ..... OFF / PEN / PLOT
  - PEN → □ CAL, □ SCALE, □ WAVEFORM, □ SCALE + WAVEFORM
- □ GP-IB ..... ADDRESS=0~30; TALK ONLY, CR, LF, CRLF

Mode Types

There are the following four STORAGE modes:

a. NORM (NORMAL) mode
b. AVERAGE mode
c. PEAK CH HOLD mode
d. ROLL mode

Set measuring conditions for one mode selected out of the four above.

Table 4-7-1 shows relations between each mode and measuring conditions.

Mode Setting

Rotary Encoder Operating Method

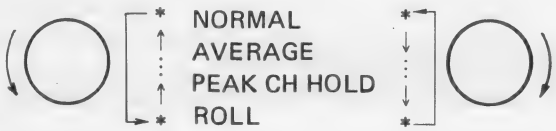


Table 4-7-1

Item \ Mode		NORM	AVERAGE	PEAK CH HOLD	ROLL
Measuring Conditions	COUNT	X	O	O	X
	REPEAT	O	O	O	X
	DATA LENGTH	O	O	O	X
	TIME BASE	O	O	O	X
	EQU-SAMPLING	O	O	O	X
	INTERPOLATION	O	O	X	X
Save and Display	SAVE	O	O	O	O
	DISPLAY	O	O	O	O
Hard Copy	OUTPUT	O	O	O	O
GP-IB	GP-IB	O	O	O	O

O : Can be set
X : Cannot be set

CAUTION

- *When MAG for the horizontal deflection system is set to OFF (x 1) in the STORAGE mode, a horizontal position is fixed.*
- *When V. MODE is set to X-Y in the STORAGE mode, shift a vertical position with the following knobs.*

CH1 (X) –CH2 (Y) . . . . . .
CH1 STORAGE POSITION
REF1 (X) –REF2 (Y) . . . . . .
CH2 STORAGE POSITION

Four-phenomenon Observation When Using the REFERENCE Memory

Setting REF of the VERT MODE to ON allows 4-phenomenon observation (CH1 display memory, CH2 display memory, REF 1 display memory, REF 2 display memory). (See Figure 4-7-1-1.)

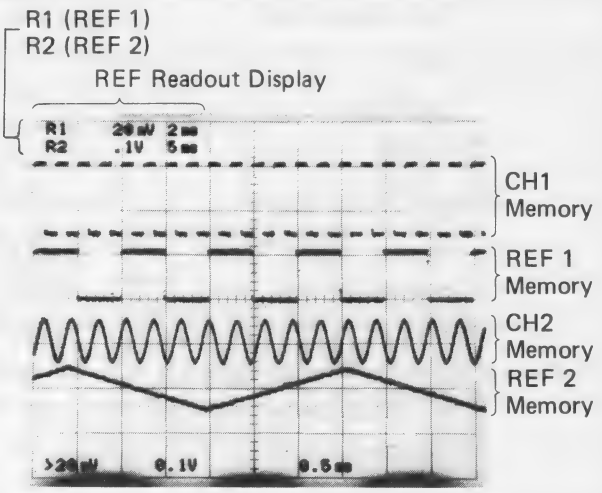
Fig. 4-7-1-2 shows relations among the input memory, save and display memory.

If SET REF is pressed, the contents of CH1 and CH2 memory display will be shifted to REF memories in accordance with setting of V. MODE.

Readout display

- When a memory card is inserted, CH1 waveform is stared in the upper REF memory No. and CH2 waveform is stored in the lower REF memory No.
- When a memory card is not inserted, CH1 waveform is stored in REF 1 and CH2 waveform is stored in REF 2.

Figure 4-7-1-1. Four-phenomenon Observation



Main memory and memory cards

Memory cards can store waveforms as an extention of REF memory. Refer to the following table and Figure 4-7-1-2.

DS-8606C / card	REF memory number	Battery backup
DS-8606C	REF 1, REF 2	Unavailable
Memory card	*1 REF 3 ~ REF 122	Available

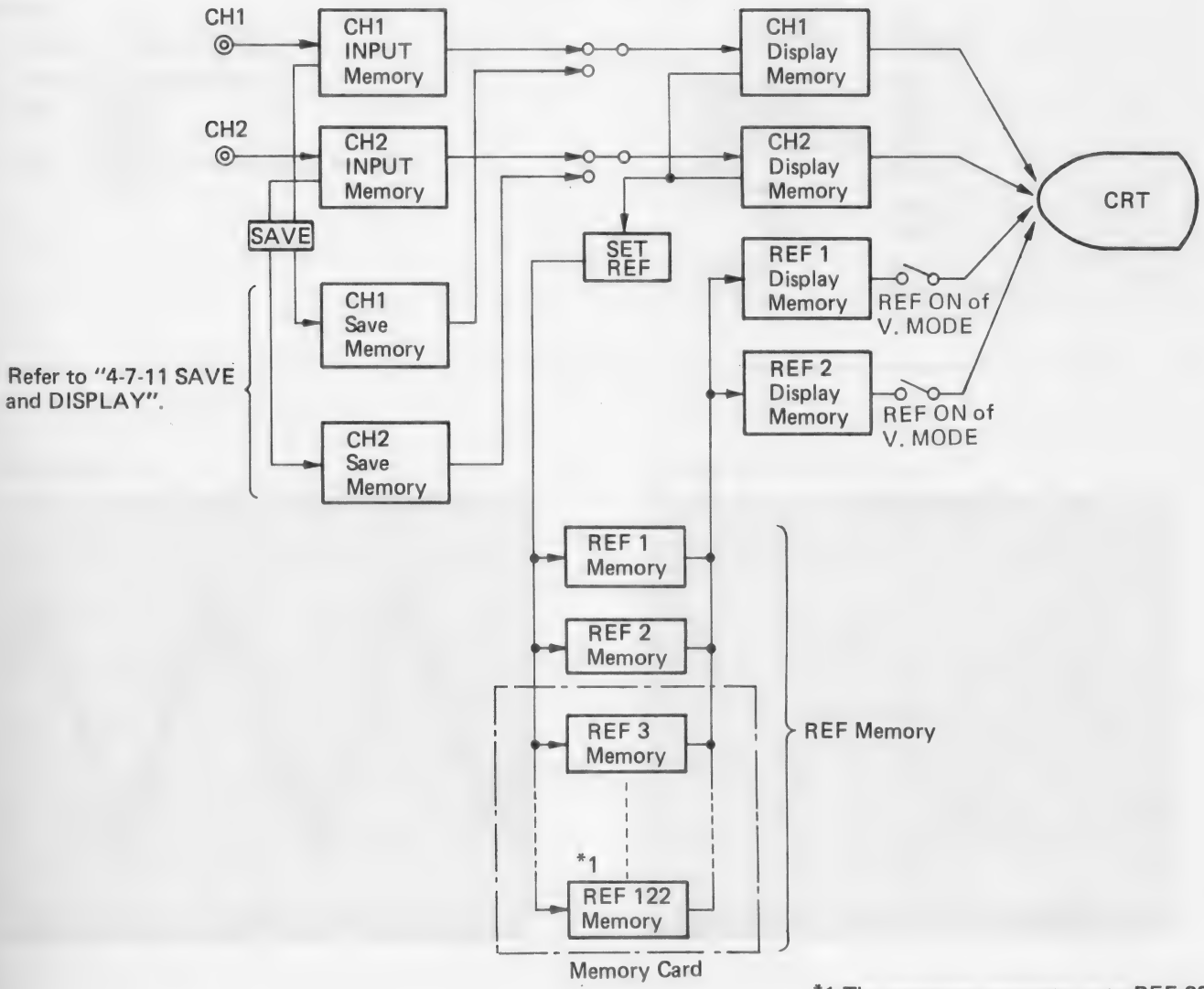
*1 The accessory memory is REF 3 ~ REF 32.

Memory card character display

The following figure shows a sample character display of a memory card. For details, refer to "4-9 MEMORY CARD".

```
MEMORY CARD
 FORMAT
 AUTO ADVANCE   OFF
    START
    STOP
?  COUNT UP      AUTO
```

Figure 4-7-1-2. Memory Block Diagram



*1 The accessory supports up to REF 32.

4-7-1 NORMAL Mode

This mode is for normal measurement.

Procedure

① Set a "*" mark to NORMAL.
② Set measuring conditions
③ Press RUN/STOP .

```
? STORAGE MODE * NORMAL
                AVERAGE
                PEAK CH HOLD
                ROLL

      COUNT
      REPEAT      ON(0SEC)

DATA LENGTH       1KW
TIME BASE         INT
EQU-SAMPLING      OFF
INTERPOLATION     OFF
SAVE              CH1
DISPLAY
      CH1         INPUT
      CH2         INPUT

OUTPUT            OFF
GP-IB             ADDRESS=5;LF
```

4-7-2 AVERAGE Mode

Averaging is used when increasing a signal S/N ratio. That is, this is used when you want to decrease only noise components of the repetition signal containing noises. However, it requires the trigger signal synchronous with the repetition signal.

The number of averaging times which can be set is 2, 4, 8, 16, 32, 64, 128 and 256.

The averaging depends on the set data length. In the 16 kw/CH mode, the compressed data is averaged, in 1kw/CH mode the data which is taken in is averaged.

Procedure

① Set the "*" mark to AVERAGE.

② Set measuring conditions

③ Press [RUN/STOP].

Press [RUN/STOP] when stopping halfway.

Averaging Method

Perform simple averaging at 2^n.

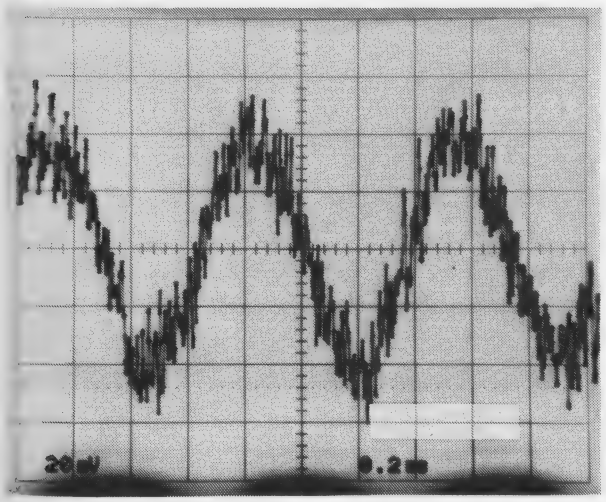
A noise component damping rate is $1/\sqrt{N}$ ('N' means the number of averaging times).

For example, assuming that the number of averaging times is 256, when the noise of 100 mV enters into the sinusoidal wave of 1 V, the noise is reduced to 6.25 mV, which means that the S/N ratio is improved by 24.1 dB.

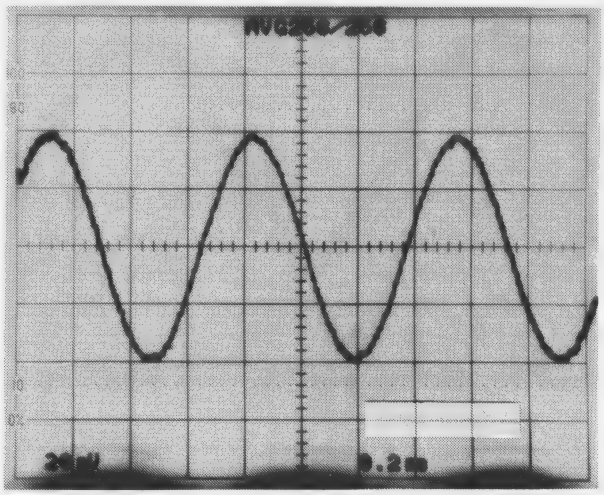
```
? STORAGE MODE    NORMAL
                * AVERAGE
                  PEAK CH HOLD
                  ROLL

        COUNT     32
        REPEAT    ON(0SEC)

DATA LENGTH       1KW
TIME BASE         INT
EQV-SAMPLING      OFF
INTERPOLATION     OFF
SAVE              CH1
DISPLAY
        CH1       INPUT
        CH2       INPUT

OUTPUT            OFF
GP-IB             ADDRESS=5;LF
```

Figure 4-7-2. AVERAGE

AVERAGE OFF



AVERAGE ON (256 Times)



4-7-3 PEAK CH HOLD Mode

This mode performs MAX or MIN processing per sampling and holds it. It is effective for glitch detection and measurement of a frequency change.

Procedure

① Set the "*" mark to PEAK CH HOLD.
② Set measuring conditions.
③ Press [RUN/STOP] .

Press [RUN/STOP] when stopping halfway.

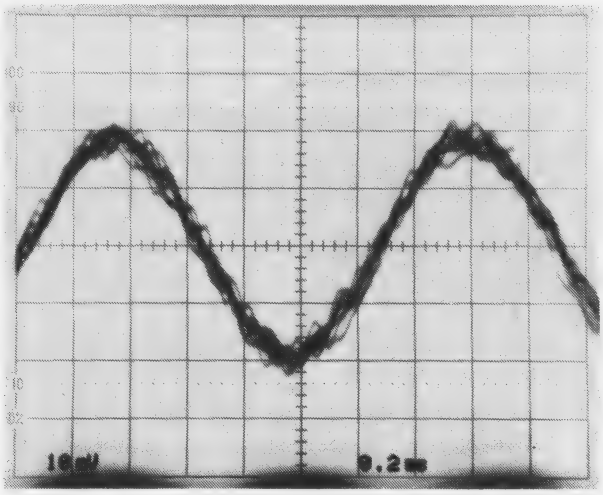
[Note] When ∞ is selected: A waveform is continuously taken in until STOP is pressed.

The number of waveform fetch times which can be set is 2, 4, 8, 16, 32, 64, 128, 256 and ∞.

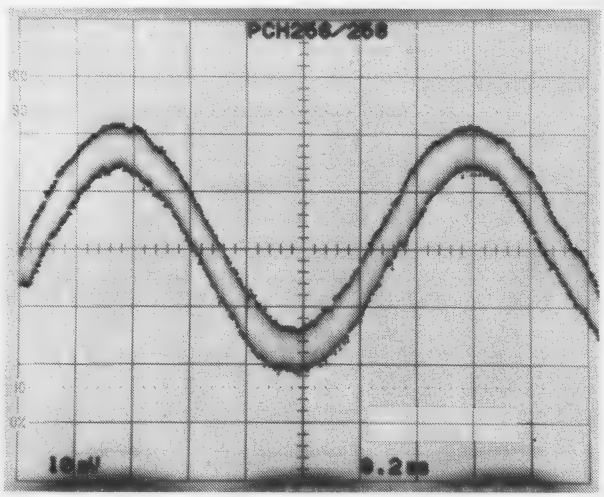
```
? STORAGE MODE     NORMAL
                   AVERAGE
                 * PEAK CH HOLD
                   ROLL

       COUNT       32
       REPEAT      ON(0SEC)

  DATA LENGTH      1KW
  TIME BASE        INT
  EQU-SAMPLING     OFF
  INTERPOLATION
  SAVE             CH1
  DISPLAY
       CH1         INPUT
       CH2         INPUT

  OUTPUT           OFF
  GP-IB            ADDRESS=5;LF
```

Figure 4-7-3. PEAK CH HOLD

REAL



PEAK CH HOLD ON (256 Times)



4-7-4 ROLL Mode

If an input signal is written with a slow-repetition clock (slow SEC/DIV range), writing takes a considerable time and it cannot be observed what signals are being input during that time.

In the ROLL mode, every time one word worth of data is written, new data is displayed on the right end of the screen and the data taken in is sequentially shifted word by word to the left, thus facilitating observation of an input signal with a slow clock.

Setting the ROLL mode reduces the sweep time to 1/1,000. Table 4-7-4 shows time relations between the REAL and ROLL modes.

Table 4-7-4

Mode	Sweep Time											
ROLL mode excluded	50ns to 0.1ms	0.2ms	0.5ms	1ms	2ms	5ms	10 ms	20ms	50ms	0.1 s	0.2 s	0.5 s
ROLL mode	0.1 s	0.2 s	0.5 s	1 s	2 s	5 s	10 s	20 s	50 s	100 s	200 s	500 s

Procedure

① Set the "*" mark to ROLL.

② Press RUN/STOP.

[Note] The following cursor measurements are possible in the ROLL mode.

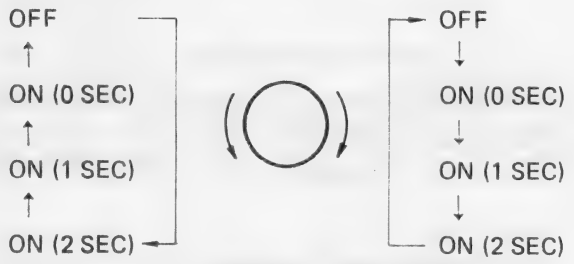
- ΔVOLTAGE
- ΔTIME
- VOLTAGE RATIO
- PHASE

```
? STORAGE MODE    NORMAL
                  AVERAGE
                  PEAK CH HOLD
                * ROLL

      COUNT
      REPEAT

DATA LENGTH
TIME BASE
EQU-SAMPLING
INTERPOLATION
SAVE              CH1
DISPLAY
      CH1         INPUT
      CH2         INPUT

OUTPUT            OFF
GP-IB             ADDRESS=5;LF
```

4-7-5 REPEAT

Select time interval OFF/ON (0 sec, 1 sec, 2 sec) from the end of measurement to the start of next measurement.

Rotary Encoder Operating Method



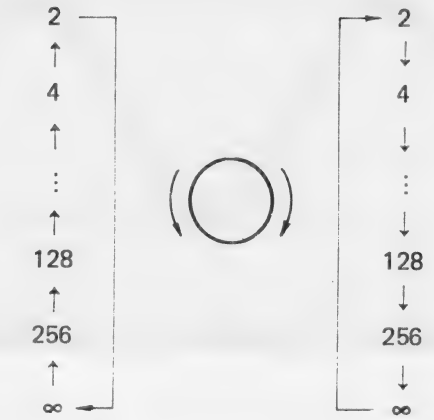
[Note] OFF cannot be set in the NORM mode.

4-7-6 COUNT

Set the number of averaging times or peak channel hold times (2, 4, 8, 16, 32, 64, 128, 256 or ∞).

'∞' can be set in case of the peak channel hold only.

Rotary Encoder Operating Method



4-7-7 DATA LENGTH

Select a data length (1 k words/CH, 16 k words/CH).

1 kw/CH : The data of 1 kw is displayed as it is.

16 kw/CH: The waveform, taken in at 16 kw/CH, is displayed with its data from the first address to 10 kw compressed to 1 kw.

To observe the data after 10 kw, Use DISP SCROLL (Refer to '4-8-12 DISP SCROLL'.).

Rotary Encoder Operating Method

4-7-8 TIME BASE

Select internal or external clocks.

Rotary Encoder Operating Method

When using the external clock, connect a clock signal to EXT CLK IN of the rear panel.

CAUTION

A maximum input voltage for EXT CLK IN is ±50 V.

Do not apply a higher voltage.

4-7-9 EQU-SAMPLING

The high-speed repetitive signals can be observed in the equivalent sampling mode. In this mode, the sampling point is shifted and A/D conversion is carried out for each sweep as shown in Fig. 4-7-9-2. So the equivalently very high sampling clock frequency can be obtained. This DS-8606C has 100 points of data per div with the maximum sweep of 50 ns/div. That is, the cycle of a clock is 50 ns/100 = 0.5 ns, and this value is equivalent to the one that is sampled by the clock of 2 GHz.

Rotary Encoder Operating Method

CAUTION

A normal waveform cannot be observed unless trigger is appropriately applied.

Pay special attention when using at high deflection factor (1 mv/div to 5 mv/div). When trigger cannot be applied appropriately, set TRIGGER COUPLING to HF REJ.

Figure 4-7-9-2. How to Catch a Waveform in the Equivalent Sampling Mode

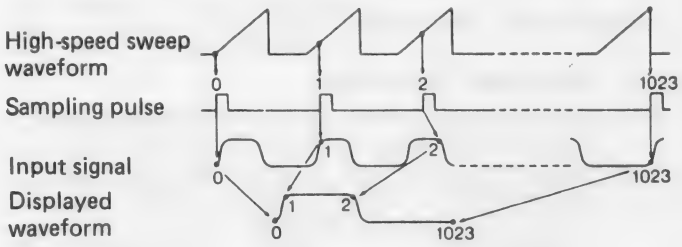
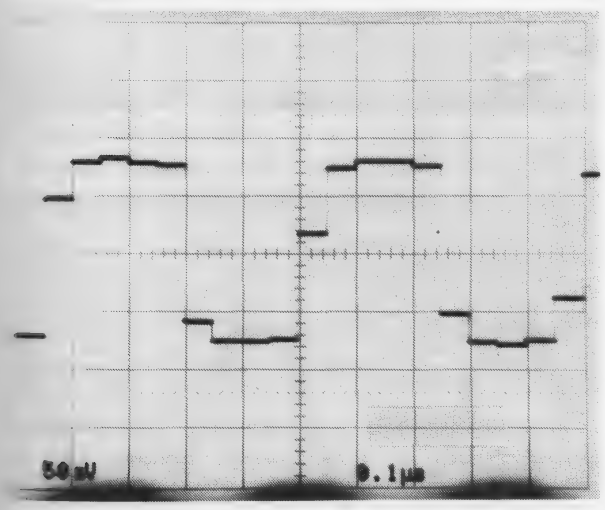
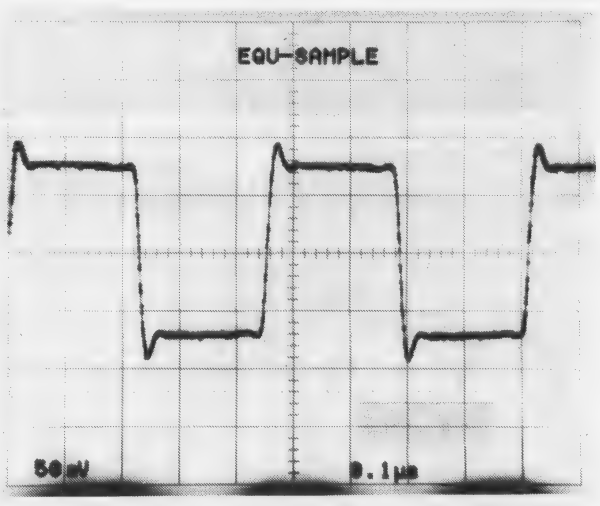


Figure 4-7-9-1. EQU-SAMPLING

EQU-SAMPLING OFF



EQU-SAMPLING ON



4-7-10 INTERPOLATION

INTERPOLATION is intended for reproducing the input waveform as faithful as possible when fewer data is taken in. The instrument is provided with two types of functions to interpolate (linear, sine). The function to interpolate becomes effective when the waveform in enlarged by more than 10 times. The linear interpolation helps to connect a datum to another linearly, and to avoid perceptual aliasing*1. The sine interpolation is intended for making a curved waveform such as a sinusoidal wave look like a sine wave and displaying it through a trigonometic function.

*1 A phenomenon that a signal seems to be another one with a different cycle in relation to the sampling cycle.

Rotary Encoder Operating Method

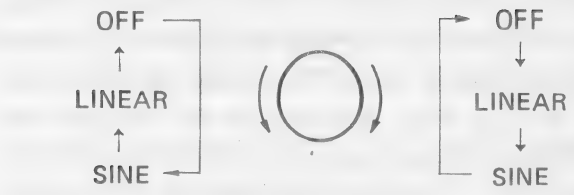
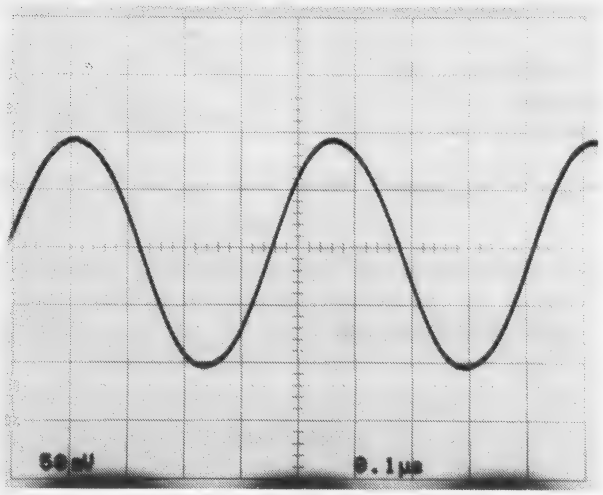
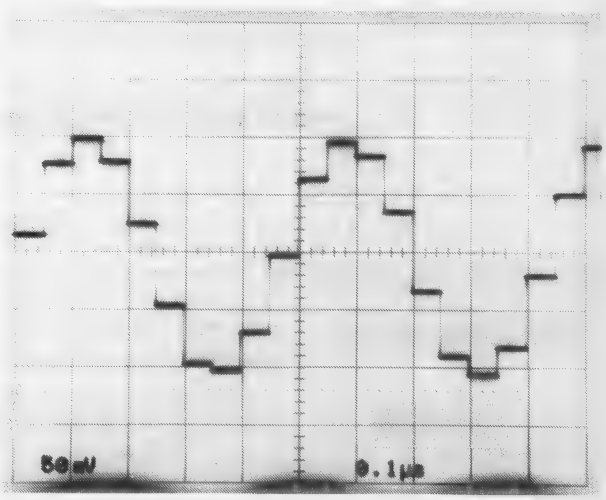


Figure 4-7-10. INTERPOLATION

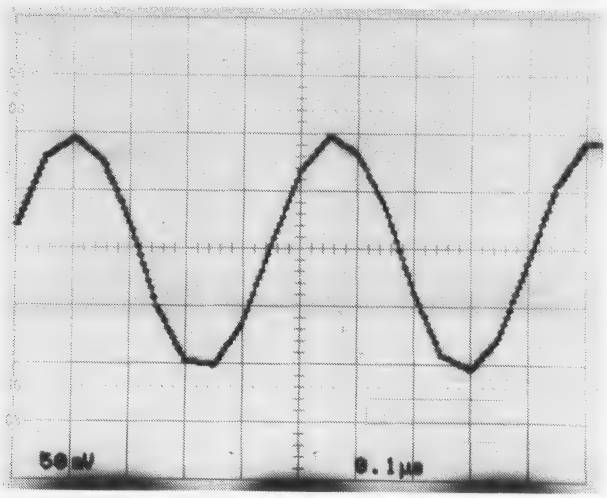
Input Signal (REAL Mode)



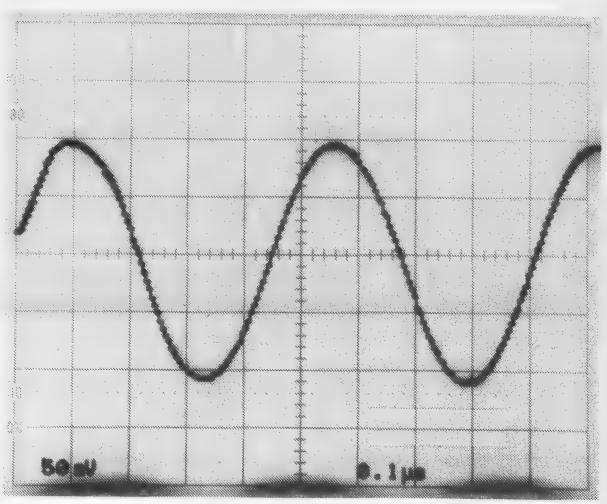
No Interpolation



Linear Interpolation



Sine Interpolation



4-7-11 SAVE and DISPLAY

A memory at the length of 16 kw is provided for each channel as a save memory. The data length of the saved waveform depends on the mode (1 kw/CH or 16 kw/CH) when taking modes, a waveform can be saved. The battery for the saved memory cannot be stored when the instrument is not powered up.

Procedure

Saving the Waveform

First, the waveform is saved in the save memory (CH1/CH2 memory).

① Set the "?" mark to SAVE.

② Select the channel (CH1/CH2).

③ Pressing [RUN/STOP] lights up the LED momentarily. Either CH1 SAVE'D or CH2 SAVE'D is momentarily displayed on the screen.

Displaying the Waveform

Next, the waveform saved is displayed in the display memory (CH1/CH2 memory).

See Fig. 4-7-1-2 (Page 4-23).

④ Set the "?" mark to DISPLAY.

⑤ Select the waveform to be displayed.

INPUT : Displays the input waveform as it is.

SAVE'D : Displays the saved waveform as it is.

⑥ Press [RUN/STOP].

4-7-12 OUTPUT

There are two output methods; one is to output to the pen recorder through no interface, and the other is to output to the plotter (HP-GL format) with the interface (GP-IB or RS-232C).

a. Pen Recorder Output

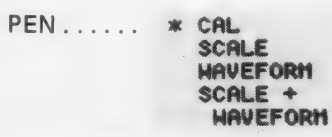
Procedure

① Connect X OUT, Y OUT and PEN UP OUT on the rear panel to X INPUT, Y INPUT and PEN UP INPUT of the pen recorder, using respective cables.

② Set the "?" mark to OUTPUT.

③ Select the pen recorder.

④ Select pen recorder output (CAL, SCALE, WAVEFORM, SCALE + WAVEFORM) by the index key ([⇧] or [⇩])



⑤ Pressing [RUN/STOP] starts output.

CAUTIONS

- *When pen recorder is selected, the keys [⇧] and [⇩] function as pen recroder output selector keys. When you use these keys as item selector keys, set to either OFF or PLOT.*
- *While the waveform is being output, [RUN/STOP] key is effective only for the pen recorder. To use the key to take in the waveform, set OUTPUT to OFF.*

b. Plotter Output

Procedure

① Connect to the plotter with a GP-IB cable or RS-232C cable.

② Set as follows when outputting with GP-IB.

Instrument : Talk Only (Refer to '5-2 INSTRUMENT INFORMATION'.)

Plotter : Listen Only

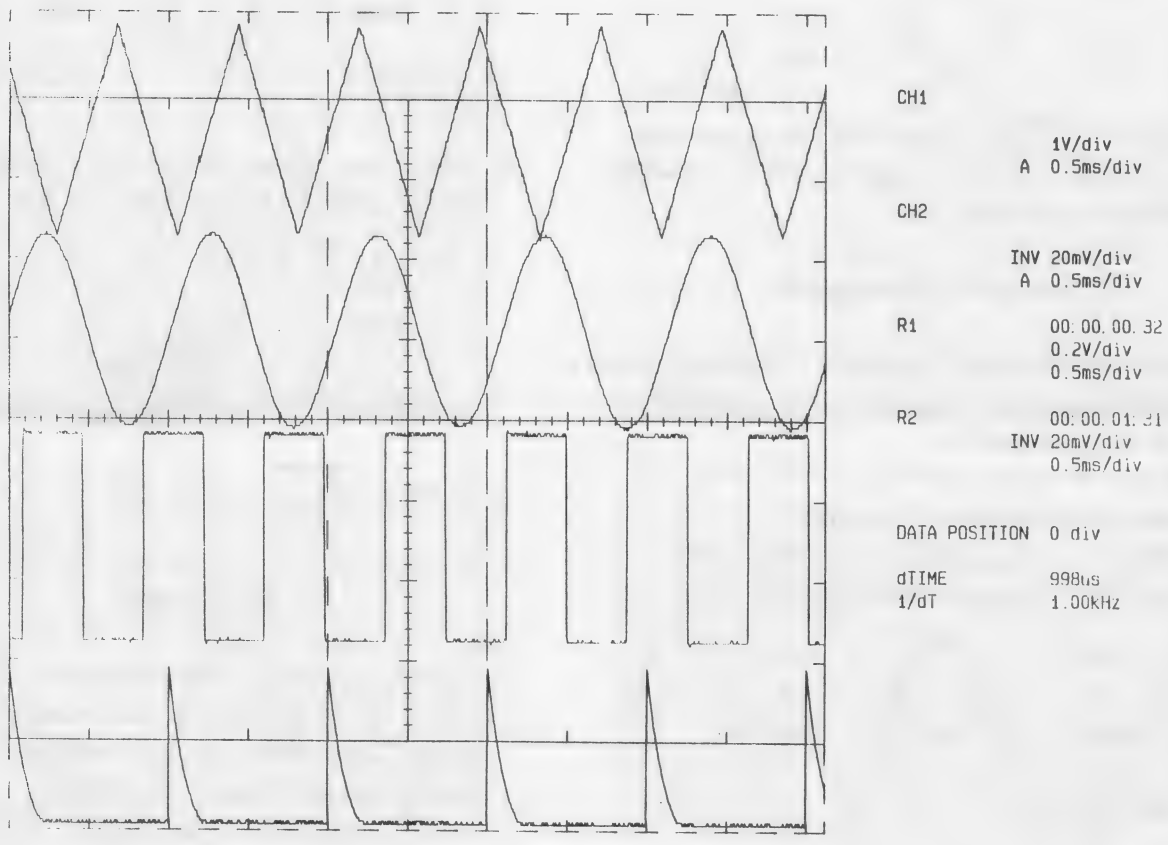
③ Set the "?" mark to OUTPUT.

④ Select the plotter.

⑤ Pressing RUN/STOP starts output.

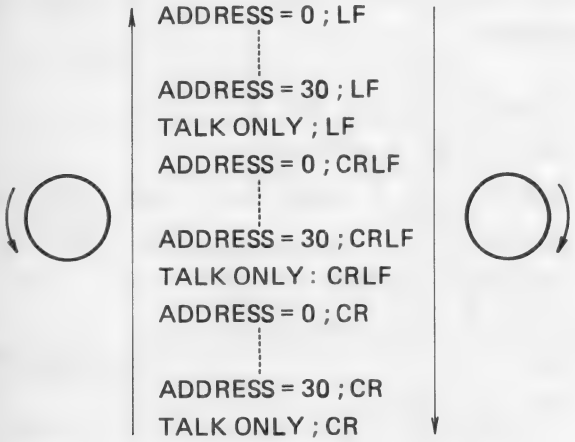
[NOTE] REF storage time (cumulative time since POWER ON when a waveform is stored in REF memory) will be output but cumulative time since POWER ON will not.

Figure 4-7-12. Plotter Output Example



4-7-13 GP-IB

Set GP-IB address, delimiter and TALK ONLY.



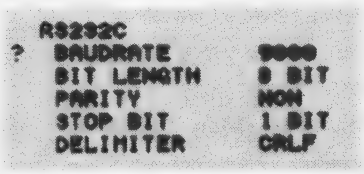
For details, see "Section 5 GP-IB".

4-7-14 RS-232C

Select RS-232C communication parameters with the Index key (⇧ , ⇩) and rotary encoder.

For details, see "Section 7 RS-232C".

Figure 4-7-14. RS-232C Character Screen



4-8 MEASUREMENT BY CURSORS

The following measurements can be done:

1 ΔVOLTAGE . . . . . .
Potential difference between cursors

2 ΔTIME . . . . . Time between cursors

1 and 2 ΔVOLTAGE and ΔTIME . . . . . .
Potential difference and time between cursors

3 VOLTAGE RATIO . . . . . Potential difference ratio

4 PHASE . . . . . Phase between cursors

5 GND REFERENCE . . . . . .
Absolute value from the GND level

6 PEAK TO PEAK . . . . . .
Difference from +Peak to −Peak between cursors

7 MAX & MIN . . . . . .
Maximum and minimum values between cursors

8 GO/NO GO . . . . . .
Judgment whether inside or outside the specified range

9 DELAY TIME . . . . . Delay time

10 DATA POSITION . . . . . Minus delay

11 DISP SCROLL . . . . . .
Enlargement of a stored waveform (stop state)

Operating Method

Every time [CURSOR] is pressed, ON/OFF is switched. The menu screen is displayed with ON position (see Figure 4-8).

○ Index keys [⇧] and [⇩]

Select the item to be measured.

Pressing [⇧] moves the "*" mark upward and pressing [⇩] moves it downward.

○ [C1] and [C2] keys

Every time [C1] or [C2] is pressed, ON/OFF is changed over.

[C1] lit up: A broken line (— — — —) moves by operating the rotary encoder.

[C2] lit up: A dotted line (. . . . . .) moves by operating the rotary encoder.

Both [C1] and [C2] lit up: The broken line and dotted line simultaneously move by operating the rotary encoder.

○ Rotary encoder

The cursors are moved upward or to the right by turning clockwise, and downward or to the left by turning counterclockwise at measurement items 1 to 8. With FINE turned on, fine adjustment is available.

Measurement item 9:
The delay time is set.

Measurement item 11:
The address is set.

○ REAL key

REAL mode when the LED is lit up.

Switches between the REAL mode and STORAGE mode.

○ STORAGE key

STORAGE mode when the LED is lit up.

Switches between the REAL mode and STORAGE mode.

○ RUN/STOP key

Every time RUN/STOP is pressed, RUN/STOP is switched over. Selecting RUN (LED lit up) starts measurement.

Selecting STOP (LED lit off) stops measurement.

Figure 4-8. Menu Screen

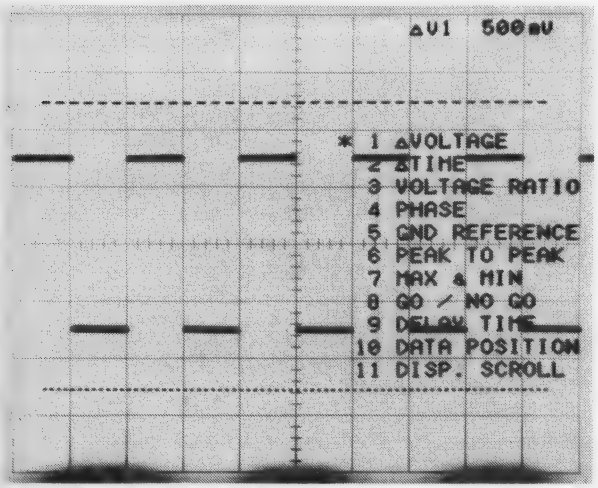


Table 4-8 shows cursor measurement enabled item at REAL (STORAGE OFF) and STORAGE.

Table 4-8

Measurement Item	REAL	STORAGE
1. △VOLTAGE	○	○
2. △TIME	○	○
3. VOLTAGE RATIO	○	○
4. PHASE	○	○
5. GND REFERENCE	—	○
6. PEAK TO PEAK	—	○
7. MAX & MIN	—	○
8. GO/NOGO	—	○
9. DELAY TIME	○*1	○*1
10. DATA POSITION	—	○*2
11. DISP SCROLL	—	○

○ : measurement enabled

— : measurement disabled

*1 Set HORIZ DISPLAY to A INTEN or B DLY'D. Other cursors can be measured, too.

*2 Other cursors can be measured, too.

CAUTION

In GND REFERENCE, PEAK TO PEAK, MAX & MIN and GO/NOGO measurement, the magnification of HORIZ can be set to 'X10', but actually, the measurements above are preferably carried out with the magnification of 'X1'.

4-8-1 ΔVOLTAGE

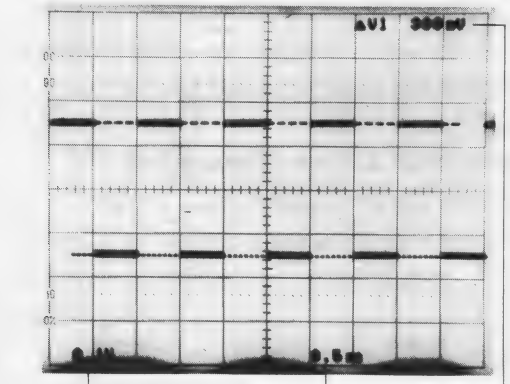
Measures a potential difference between two cursors.

Procedure

① On the Guide Menu screen, set the "*" mark to 1 ΔVOLTAGE.

```
* 1 ΔVOLTAGE
  2 ΔTIME
  3 VOLTAGE RATIO
  4 PHASE
  5 GND REFERENCE
  6 PEAK TO PEAK
  7 MAX & MIN
  8 GO / NO GO
  9 DELAY TIME
 10 DATA POSITION
 11 DISP. SCROLL
```

② Set the cursors to positions to be measured.



CAUTION

When a waveform is stopped in the STORAGE mode:
When changing VOLTS/DIV and setting VERT X5, the waveform will not be changed, so the measured value does not need changing. If the magnification of SEC/DIV is changed, the waveform will be changed, so the measurement value needs changing.

4-8-2 ΔTIME

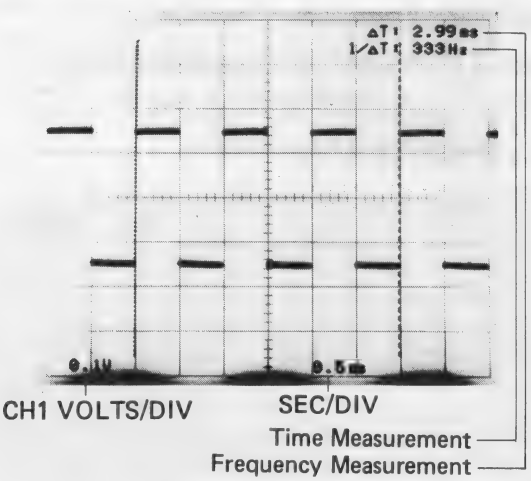
Measures a time between two cursors and the frequency whose cycle is the time.

Procedure

① On the Guide Menu screen, set the "*" mark to 2 Δ TIME.

```
  1 ΔVOLTAGE
* 2 ΔTIME
  3 VOLTAGE RATIO
  4 PHASE
  5 GND REFERENCE
  6 PEAK TO PEAK
  7 MAX & MIN
  8 GO / NO GO
  9 DELAY TIME
 10 DATA POSITION
 11 DISP. SCROLL
```

② Set the cursors to positions to be measured.



CAUTION

REAL

If SEC/DIV is set to UNCAL, ΔT will be displayed with ">" and 1/ΔT will be displayed with "<".

STORAGE

Not in EQU mode: VARIABLE of SEC/DIV is disabled. It cannot be set to UNCAL.

In EQU mode: VARIABLE of SEC/DIV is enabled. It can be set to UNCAL.

Measured Value Display of ΔT and 1/ΔT

Although cursor resolution has 4,096 bits, it is displayed in 3 digits (cut less than 4th digit off). Therefore, there may be an error of up to 1% between measured values of ΔT and 1/ΔT.

4-8-3 ΔVOLTAGE and ΔTIME

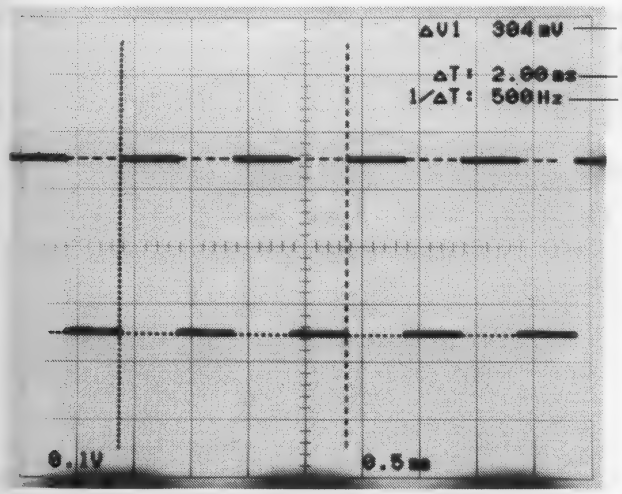
Simultaneously measures a potential difference and a time.

Procedure

① On the Guide Menu screen, set the "*" mark to 1 ΔVOLTAGE and 2 ΔTIME.

```
* 1 ΔVOLTAGE
* 2 ΔTIME
  3 VOLTAGE RATIO
  4 PHASE
  5 GND REFERENCE
  6 PEAK TO PEAK
  7 MAX & MIN
  8 GO / NO GO
  9 DELAY TIME
 10 DATA POSITION
 11 DISP. SCROLL
```

② Adjust the cursors to positions to be measured.



Potential Difference Measurement

Time Measurement

Frequency Measurement

Rotary Encoder Using Method

Pressing [SET] switches over the cursors (ΔVOLTAGE and ΔTIME) which can be set by the rotary encoder.

ΔVOLTAGE Cursor → [SET] → ΔTIME Cursor → [SET]

CAUTION

REAL

If SEC/DIV is set to UNCAL, ΔT will be displayed with ">" and 1/ΔT will be displayed with "<".

STORAGE

Not in EQU mode: VARIABLE of SEC/DIV is disabled. It cannot be set to UNCAL.

In EQU mode: VARIABLE of SEC/DIV is enabled. It can be set to UNCAL.

4-8-4 VOLTAGE RATIO

Measures a ratio to a reference potential.

Procedure

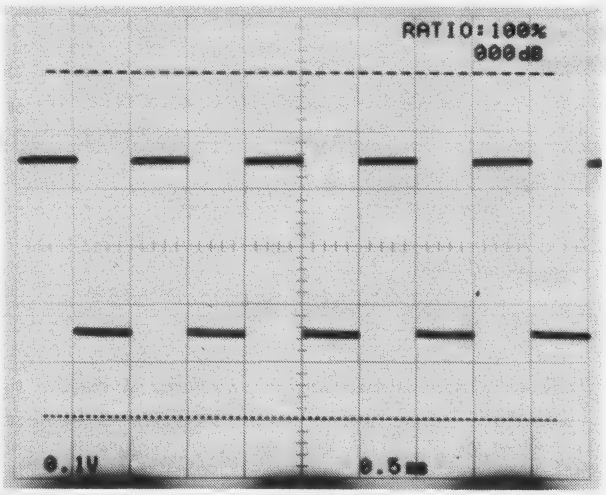
① On the Guide Menu screen, set the "*" mark to 3 VOLTAGE RATIO.

```
  1 ΔVOLTAGE
  2 ΔTIME
* 3 VOLTAGE RATIO
  4 PHASE
  5 GND REFERENCE
  6 PEAK TO PEAK
  7 MAX & MIN
  8 GO / NO GO
  9 DELAY TIME
 10 DATA POSITION
 11 DISP. SCROLL
```

② Set a reference potential with two cursors.

③ Press [SET] .

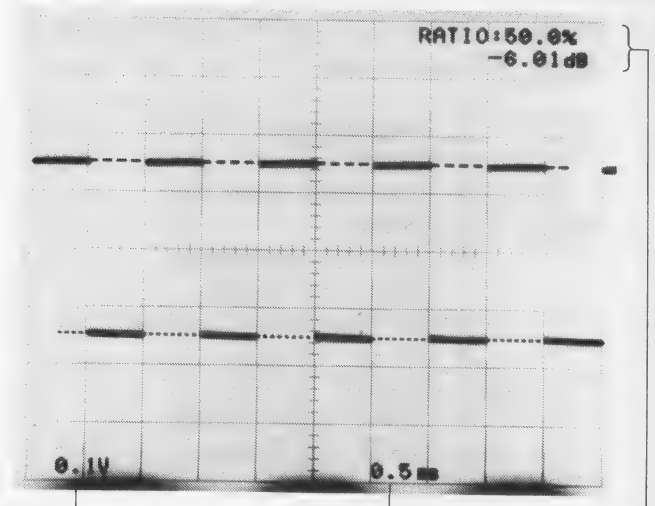
This sets an inter-cursor ratio to 100% and 0 dB.



Setting of 6 Divisions between 2 Cursors as Reference Value

④ Set the cursors to positions to be measured.

Measure a ratio to 6 divisions between the cursors set in ③ .



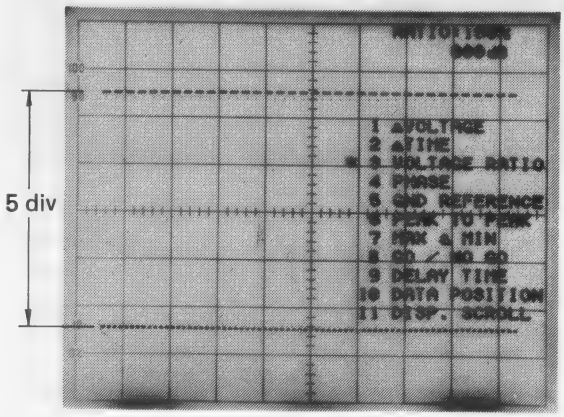
CH1 VOLTS/DIV

SEC/DIV

Voltage Ratio Measurement

Reference value to be set when powered on:

The position of the cursor, when powered on, is as follows. 5 divisions between 2 cursors are set as 100%, 0 dB.



4-8-5 PHASE

Measures a phase difference from a reference waveform.

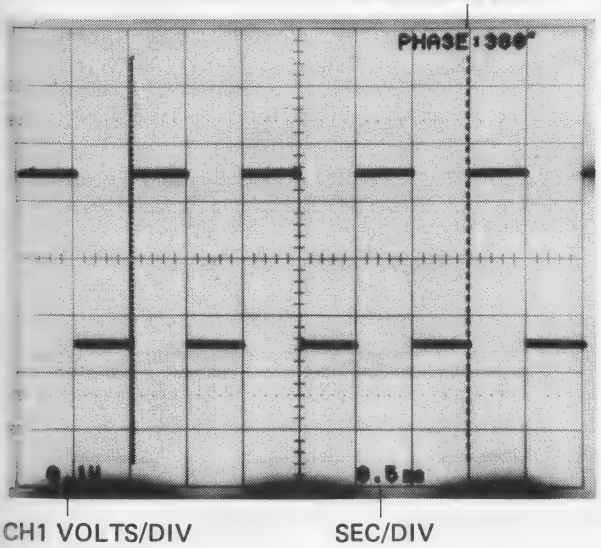
Procedure

① On the Guide Menu screen, set the "*" mark to 4 PHASE.

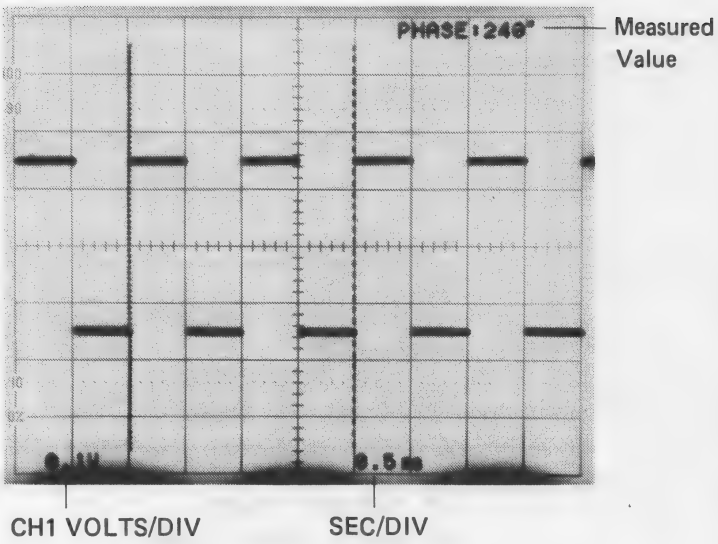
```
  1 ΔVOLTAGE
  2 ΔTIME
  3 VOLTAGE RATIO
* 4 PHASE
  5 GND REFERENCE
  6 PEAK TO PEAK
  7 MAX & MIN
  8 GO / NO GO
  9 DELAY TIME
 10 DATA POSITION
 11 DISP. SCROLL
```

② Set two cursors to reference positions.

③ Press [SET] to set an inter-cursor phase to 360°.

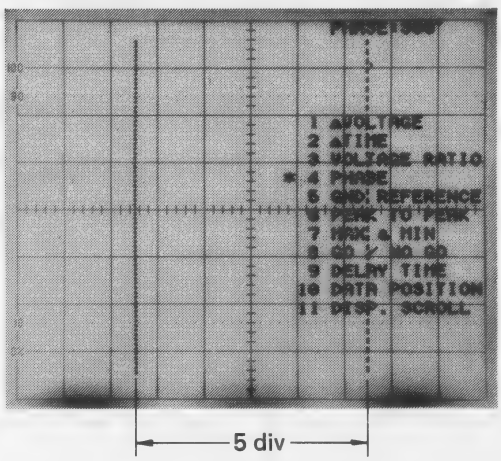


④ Set the cursors to positions to be measured.



Reference value to be set when powered on:

The position of the cursor, when powered on, is as follows. 5 divisions between 2 cursors are set as 360°.



4-8-6 GND REFERENCE

Detect a ground potential and measures a potential difference from the ground potential.

Procedure

① Set STORAGE to ON.

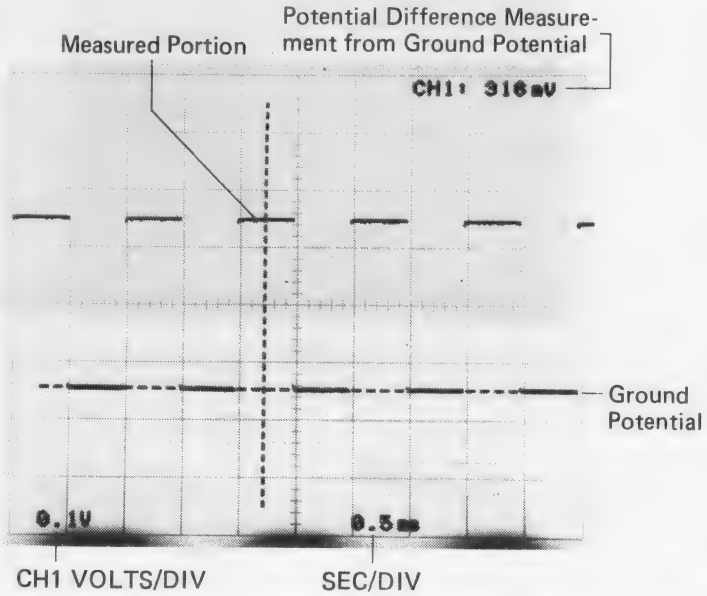
② On the Guide Menu screen, set the "*" mark to 5 GND REFERENCE.

```
  1 ΔVOLTAGE
  2 ΔTIME
  3 VOLTAGE RATIO
  4 PHASE
* 5 GND REFERENCE
  6 PEAK TO PEAK
  7 MAX & MIN
  8 GO / NO GO
  9 DELAY TIME
 10 DATA POSITION
 11 DISP. SCROLL
```

③ Set a ground potential with REAL POSITION and press [SET]. A new ground potential is indicated with a dotted line.

④ Set the cursor to position to be measured.

⑤ Set [RUN/STOP] to RUN.



4-8-7 PEAK TO PEAK (Maximum amplitude)

Measures the difference from maximum to minimum values between two cursors.

Procedure

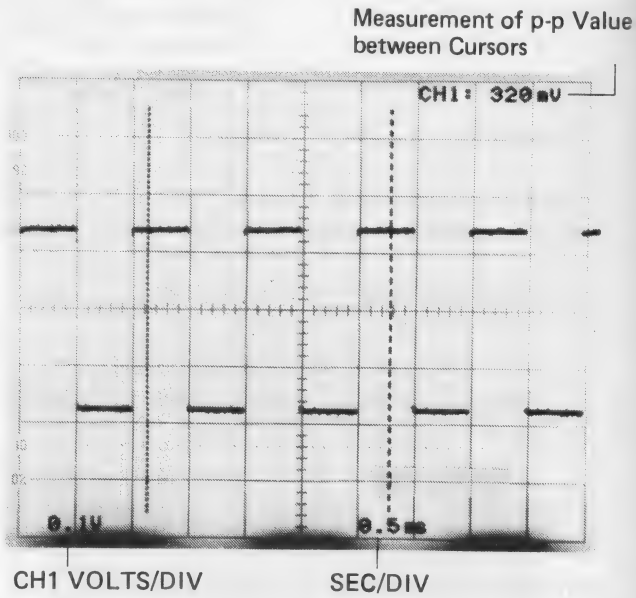
① Set STORAGE to ON.

② On the Guide Menu screen, set the "*" mark to 6 PEAK TO PEAK.

```
  1 ΔVOLTAGE
  2 ΔTIME
  3 VOLTAGE RATIO
  4 PHASE
  5 GND REFERENCE
* 6 PEAK TO PEAK
  7 MAX & MIN
  8 GO / NO GO
  9 DELAY TIME
 10 DATA POSITION
 11 DISP. SCROLL
```

③ Set the cursors to positions to be measured.

④ Set [RUN/STOP] to RUN.



4-8-8 MAX & MIN

Sets a reference potential and measures maximum and minimum values from the reference potential.

Procedure

① Set STORAGE to ON.

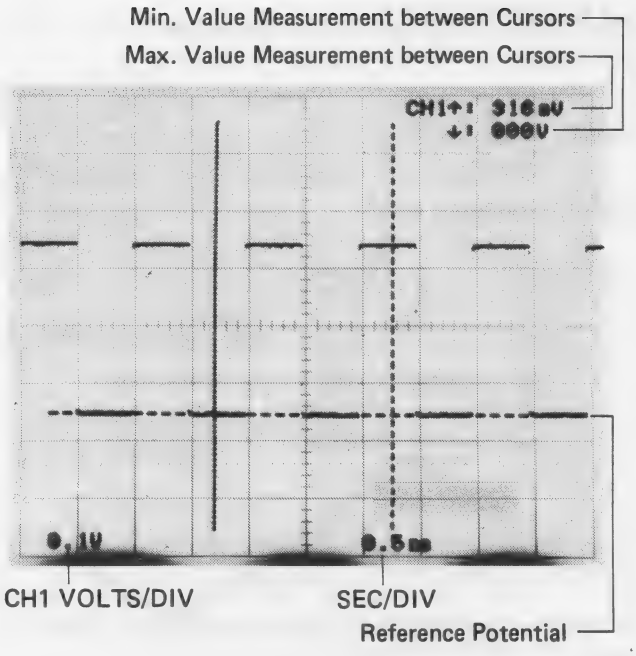
② On the Guide Menu screen, set the "*" makr to 7 MAX & MIN.

```
  1 ΔVOLTAGE
  2 ΔTIME
  3 VOLTAGE RATIO
  4 PHASE
  5 GND REFERENCE
  6 PEAK TO PEAK
* 7 MAX & MIN
  8 GO / NO GO
  9 DELAY TIME
 10 DATA POSITION
 11 DISP. SCROLL
```

③ Set a reference position with REAL POSITION and press [SET] . A new reference position is indicated with a dotted line.

④ Set the cursors to positions to be measured.

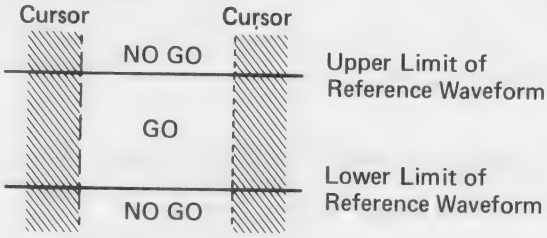
⑤ Set [RUN/STOP] to RUN.



4-8-9 GO/NO GO

Judges whether or not a measured waveform is within a preset range.

Set a judgment area with two vertical cursors and a reference waveform width.



Out of GO/NO GO Judgment

A reference waveform changes depending on V. MODE setting.

For CH1 . . . . . REF 1 as a reference
For CH2 . . . . . REF 2 as a reference
For DUAL . . . . . REF 1 as a reference

CAUTION

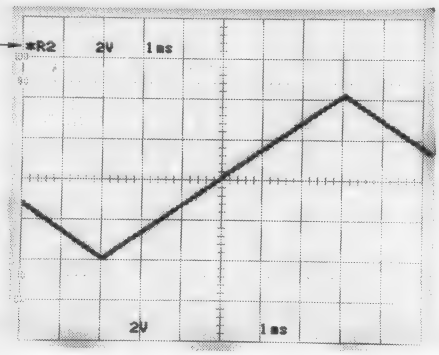
Judgment becomes unstable if a greatly changing signal is used as a reference waveform.

Procedure

① Set STORAGE to ON by pressing [STORAGE] .

② Write the reference waveform to a REF memory by pressing [SET REF] .

[Note] →



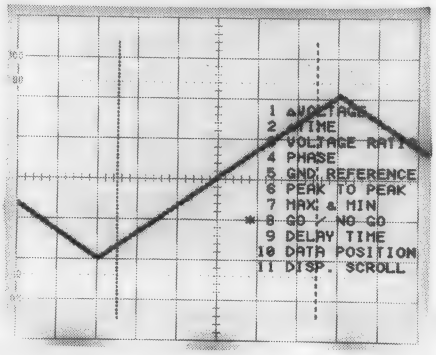
[Note] Even when a memory card is inserted, "*" mark may not be displayed. In this case, "*" appears if [SET REF] is pressed.

When [SET REF] is pressed again, the waveform will be stored in the REF memory.

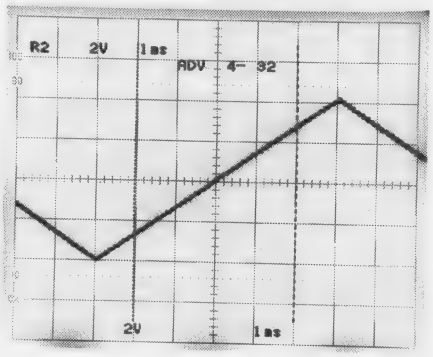
Judging area setting of GO/NO GO

③ The Guide Menu screen is displayed when [CURSORS] is pressed.

④ Set "*" mark to GO/NO GO on this screen.

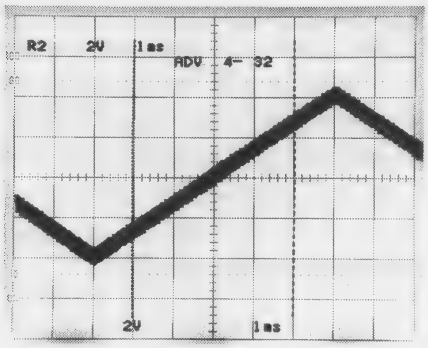


⑤ Using the rotary encoder, set a HORIZ. axis NO GO range (cursor displays).



⑥ Press [SET] .

⑦ Using the rotary encoder, set the vertical axis NO GO range (waveform displays).



- Rotary Encoder Using Method

The NO GO ranges (vertical axis and horizontal axis) which can be set with the rotary encoder are switched every time [SET] is pressed.

Cursor Setting → [SET] → Setting of width of reference waveform → [SET]

CAUTION

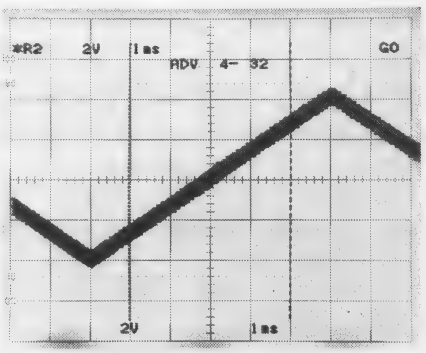
When STORAGE POSITION is turned, the vertical position seems to be changed. Also, when STORAGE VARIABLE is turned, the vertical sensitivity seems to be changed. However, those changes are just by appearance and they are nothing to do with GO/NO GO judgement. GO/NO GO judgement is made by the original waveform.

Judgement of GO/NO GO

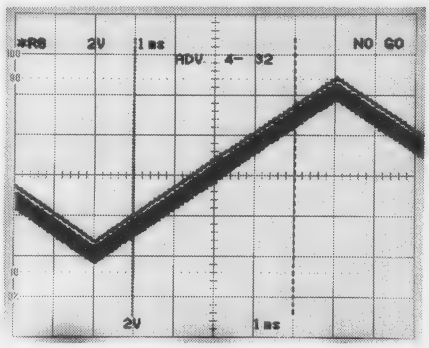
⑧ Set [RUN/STOP] to RUN.

If the waveform is within the specified range, "GO" is displayed. If it goes out of the range, "NO GO" is displayed.

"GO" is displayed because the waveform is within the range.



"NO GO" is displayed because the waveform is out of the range.



4-8-10 DELAY TIME

A INTEN and B DLY'D can be used in the REAL mode as well as the STORAGE mode. See ⑥ HORIZ DISPLAY in "4-6 Horizontal Deflection System". DELAY TIME can be used also for the measurement of other cursors.

Procedure

① Set STORAGE to ON.

② When HOLIZ DISPLAY is set to A INTEN or B DLY'D, 9 DELAY TIME in the Guide Menu is selected automatically.

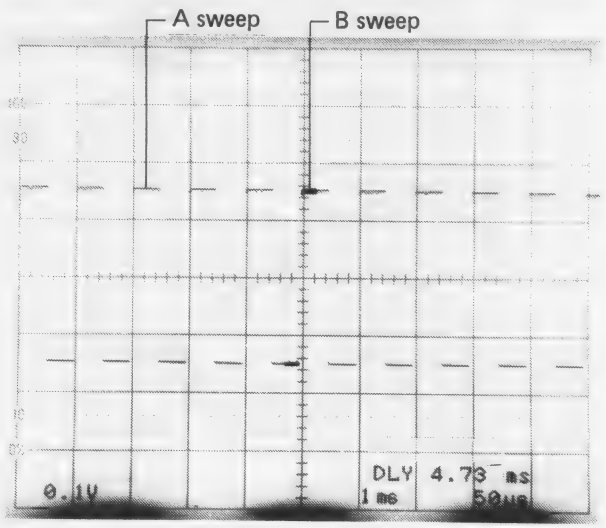
[Note] When it is set to A INTEN or B DLY'D beforehand, and other cursors are measured, fit the "*" screen for the Guide Menu.

```
  1 ΔVOLTAGE
  2 ΔTIME
  3 VOLTAGE RATIO
  4 PHASE
  5 GND REFERENCE
  6 PEAK TO PEAK
  7 MAX & MIN
  8 GO / NO GO
* 9 DELAY TIME
 10 DATA POSITION
 11 DISP. SCROLL
```

When the Guide Menu is not displayed, set HORIZ DISPLAY to A INTEN to select 9 DELAY TIME.

③ Set a delay time with the rotary encoder. In case of the following figure, set DLY = 4.73 ms.

A INTEN



④ Setting HORIZ DISPLAY to B DLY'D, B sweep is enlarged on the screen.

4-8-11 DATA POSITION

The data position function causes the phenomenon before triggering to be caught surely. The trigger point (data position) can be set to 0 to 10 div with the increment of 1 div on the screen, in measuring the vertical cursor. Once set, it is effective unless it is changed, and can be used also for measuring other cursors. When it is set, "DTP = n" is displayed at the bottom right of the screen to indicate the data position. The position serves as a reference point for the reduction or enlargement of the waveform that is taken in (stopped).

Procedure

① Set STORAGE to ON.

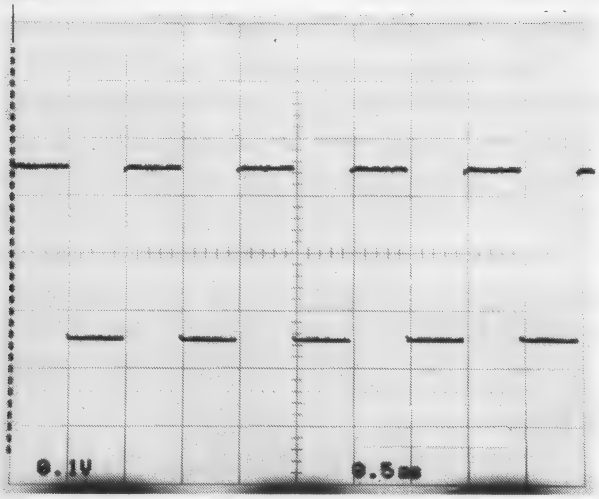
② On the Guide Menu screen, set the "*" mark to 10 DATA POSITION.

```
  1 ΔVOLTAGE
  2 ΔTIME
  3 VOLTAGE RATIO
  4 PHASE
  5 GND REFERENCE
  6 PEAK TO PEAK
  7 MAX & MIN
  8 GO / NO GO
  9 DELAY TIME
*10 DATA POSITION
 11 DISP. SCROLL
```

③ Set the cursors to positions to be measured. The trigger point changes by 1 division.

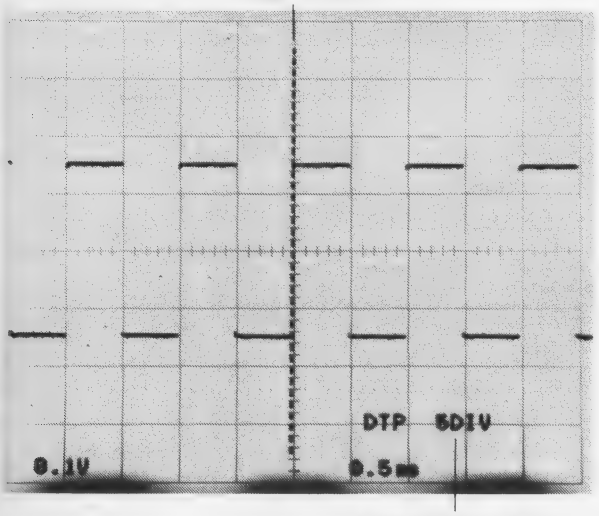
a. Measuring after Trigger Point

Trigger Point



b. Measuring 5 Divisions before Trigger Point

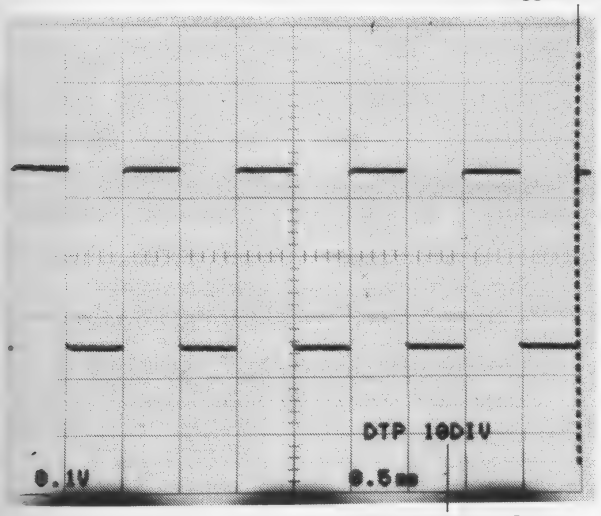
Trigger Point



Data Position 5 div

c. Measuring 10 Divisions before Trigger Point

Trigger Point



Data Position 10 div

Combined Use with DELAY TIME

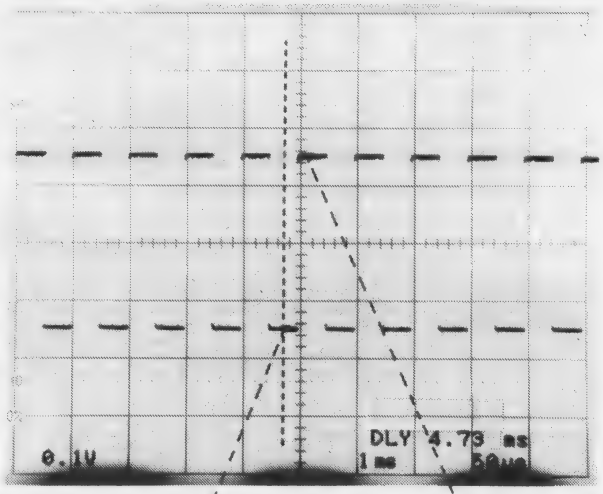
B SWEEP and Data Position

In A INTEN and B DLY'D, a data position is effective to B SWEEP, having no relation to A SWEEP.

In the condition ③ 'A delay time' shown on the left page;

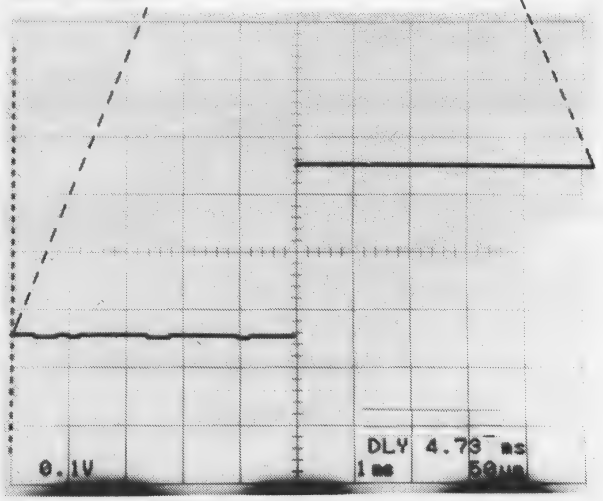
① Pressing [⇩] results in the DATA POSITION mode.

A INTEN



② Set HORIZ DISPLAY to DLY'D.

Data Position 0



Data position and waveform display range.

Refer to Fig. 4-8-11-1.

Relation between data position and trigger point at the data length of 16 kw/CH.

Refer to Fig. 4-8-11-2.

Figure 4-8-11-1. Data Position and Waveform Display Range

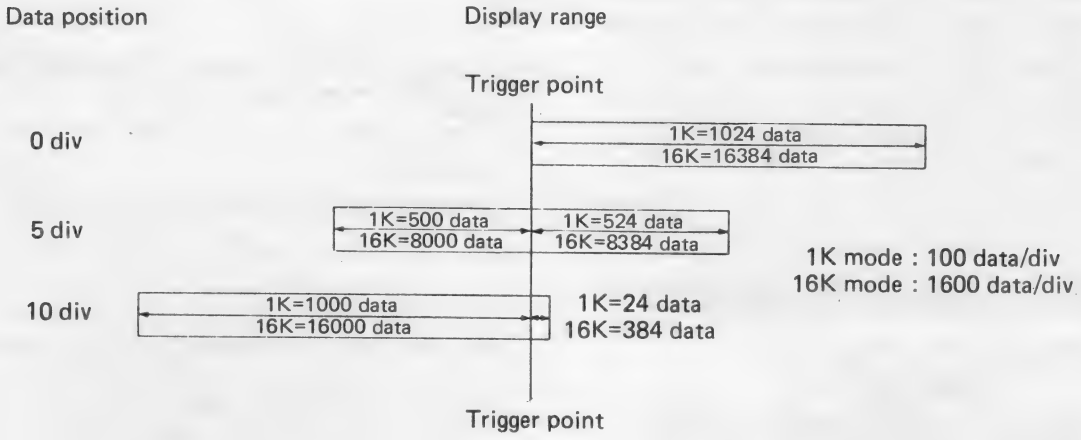
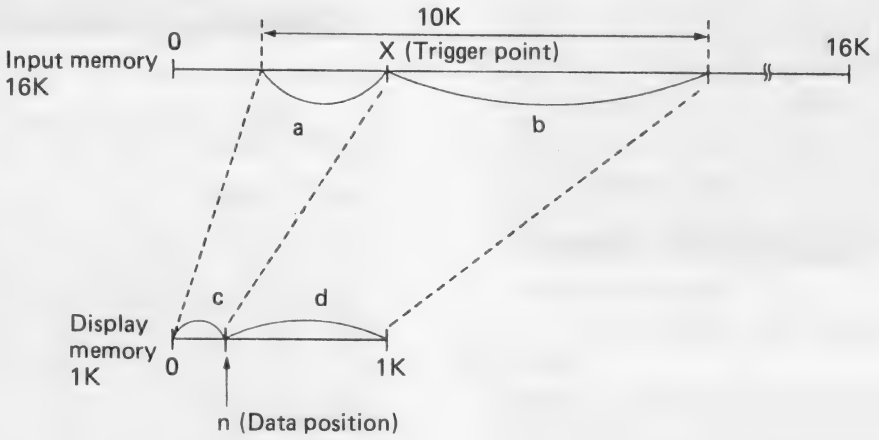


Figure 4-8-11-2. Relation between Data Position and Trigger Point



$$X \text{ (Trigger point)} = 16000 \times \frac{n}{10}$$

n : Data position

Relation between input memory and display memory

a : b = c : d

4-8-12 DISP SCROLL

When the stored waveform is stopped, it can be enlarged up to 100 times at the data position using SEC/DIV.

By setting the data length at 10 kw/CH and using the DISP SCROLL function, the whole area of the waveform taken in can be observed one after another. When the data length is set at 16 kw, the waveform is taken in at the speed 10 times higher (A waveform reduced to 1/10 is displayed on the screen.). With the waveform enlarged 10 times using SEC/DIV, the original waveform can disappear.

Procedure

① Set STORAGE to ON.

② Display on the screen the original waveform (See Fig. 4-8-12 a.)

③ Set RUN/STOP to STOP (lit off).

④ Enlarges the waveform with A SEC/DIV. (See Fig. 4-8-12 b.)

```
 1 ΔVOLTAGE
 2 ΔTIME
 3 VOLTAGE RATIO
 4 PHASE
 5 GND REFERENCE
 6 PEAK TO PEAK
 7 MAX & MIN
 8 GO / NO GO
 9 DELAY TIME
10 DATA POSITION
*11 DISP. SCROLL
```

⑤ On the Guide Menu screen is displayed, set the "*" mark to DISP SCROLL.

An address is displayed on the upper right part of the screen. (See Fig. 4-8-12a).

⑥ Using the rotary encoder, select a portion to be measured.

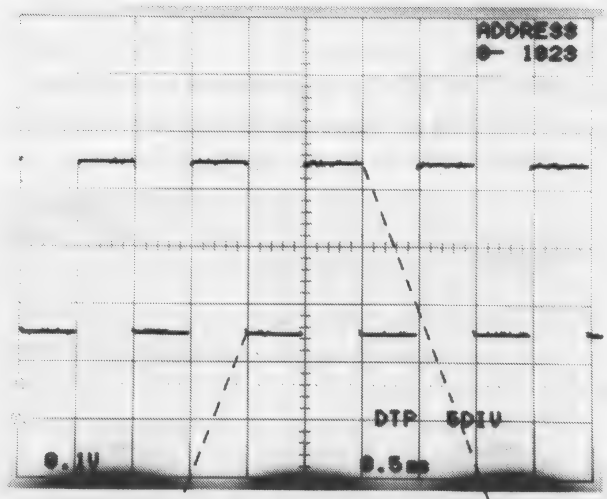
The address displayed on the upper right part is changed by adjusting the rotary encoder.

CAUTION

If RUN/STOP is set to RUN and the waveform is taken in anew, DISP SCROLL becomes invalid.

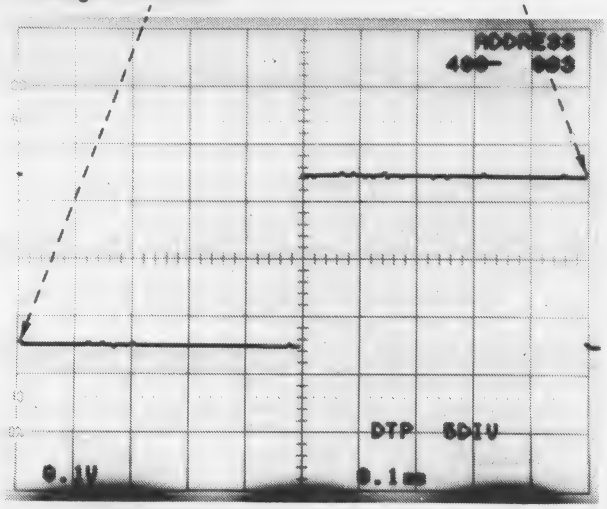
Figure 4-8-12. DISP SCROLL

a. Sotred Waveform



SEC/DIV : 0.5 ms

b. Enlarged Waveform



SEC/DIV : 0.1 ms

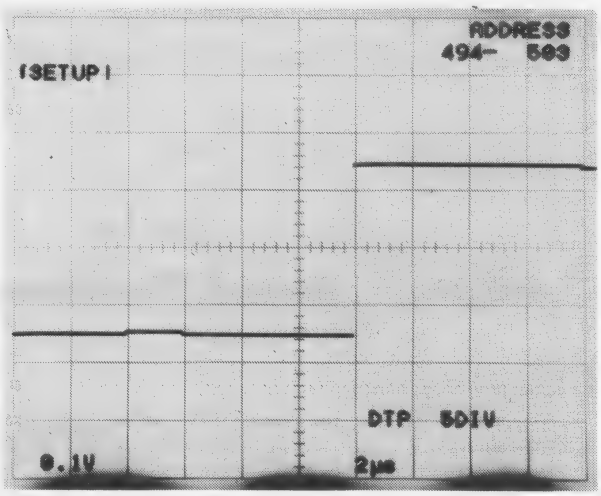
The figure b shows an enlarged view of the portion ranging from address 400 to 603 in the figure above (a).

CAUTION

! SETUP ! Display

If setting is done beyond an enlargement enabled range, "! SETUP !" will be displayed on the screen.

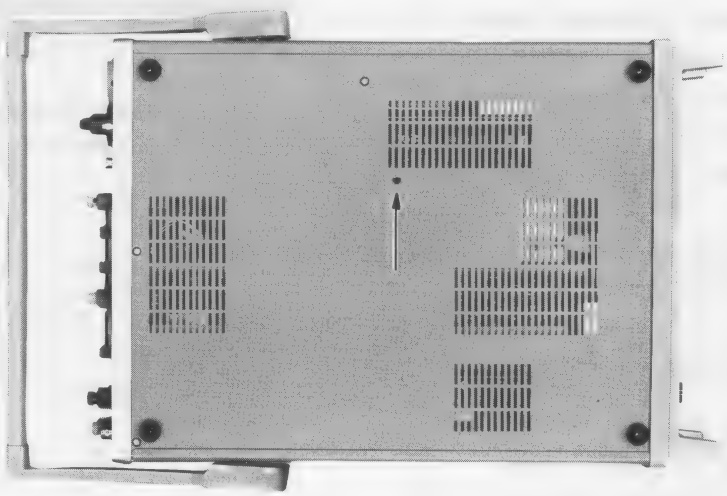
When this appears, numerals on the screen follow a change of setting, but the waveform does not.



4-9 LOCATION OF ADJUSTMENT ON THE BOTTOM OF THE UNIT

Adjust Astig with an adjusting screwdriver (see Figure 4-9).

Figure 4-9. Location of Adjustment of Astig

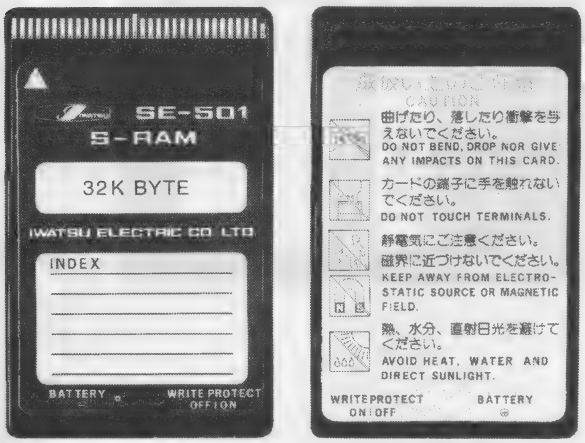


4-10 MEMORY CARD

General

- This instrument can store a waveform in a specified memory card. The waveform, collateral conditions (for example, vertical axis range, horizontal axis range, etc.) can be also stored.
- The waveform stored in the memory card is treated an extension of the REF memory. The accessory memory card can store up to 30 waveforms. REF 1 and REF 2 are not backed up by a battery because they use the memory in the DS-8606C.
- A data length is fixed at 1 kword.
- Since the memory card is backed up by the battery, the waveforms stored are not erased even if the instrument is turned off or the memory card is removed. It is very convenient for filing waveforms.

Figure 4-10-1. Accessory Memory Card



- AUTO ADVANCE
  This function automatically stores up to the stop number of the REF memory sequentially in the memory card every time an input signal is taken in.
- COUNT UP
  This function automatically updates a REF memory number after storing a waveform in the REF memory by pressing SET REF .
- TIME function
  This function allows measurement of a cumulative time since POWER ON. If a waveform is stored in the REF memory, a cumulative time starting at then power-on is automatically stored together.
- Storage of GO/NO GO Basic Waveform and Judgment Area Information
  In GO/NO GO judgment, a basic waveform and judgment area information (cursor position and basic waveform width) can be stored together to facilitate GO/NO GO setting. (See "4-8-9 GO/NO GO".)
- GO/NO GO + AUTO ADVANCE (See 4-10-11)
  NO GO judgment can be automatically stored in the memory card by combining the GO/NO GO judgment and AUTO ADVANCE functions.
  This allows an abnormal waveform, which rarely happens, to be caught in unattended operation.
  Since the TIME function is provided, the time an abnormal waveform occurred can be obtained.

If you use marketed BEE Card R/W, the data in the memory card can be directly communicated to the PC-9801 series.

Cautions

- Applicable Memory Card
  Use a specified memory card.

  There are 5 kinds of memory cards with different storage capacities:

Memory length	No. of Files	Data Length
8 K BYTE (optional)	6 + 2 (internal memory)	1 kword
16 K BYTE (optional)	14 + 2 (internal memory)	1 kword
32 K BYTE (accessory)	30 + 2 (internal memory)	1 kword
64 K BYTE (optional)	60 + 2 (internal memory)	1 kword
128 K BYTE (optional)	120 + 2 (internal memory)	1 kword

- Items Mentioned on Memory Card
  When using the memory card, strictly observe the cautions mentioned on the card.

- Memory Card WRITE PROTECT Switch
  If the WRITE PROTECT switch is turned on, data cannot be written into the memory card and formatting of the memory card is not allowed. Turn the switch off when using it. The instrument cannot detect the ON/OFF status of the WRITE PROTECT switch.

- Saving the Data
  When saving important data, turn on the memory card WRITE PROTECT switch. This prevents the data from being erased by mistake. Be fully careful of a battery service life.

- Battery Service Life
  Although a battery service life depends on an operating condition, it is roughly one year. If it runs out, the data stored in the memory card are lost.

- Replacement of Battery
  If you remove the memory card from the instrument and replace the battery, the stored data are lost.
  Follow the procedure below to replace the battery with the stored data kept.
  1. Leave the memory card inserted into the instrument.
  2. Leave the instrument turned on.
  3. Replace the battery.

Cautions

- "UNFORMAT" Display

  When the memory card has not been formatted, UNFORMAT is displayed on the screen. Check the battery and format it, because you may be using a new memory card or one whose stored data were lost due to a dead battery.

- Removal/Insertion of Memory Card While It Is Accessed

  Do not remove or insert the memory card while it is accessed. It causes malfunction. The memory card in access means the following states:

  a. Until initialization*1 of the instrument is completed after turning on power

     *1 When power is turned on, a model name and a software version are displayed on the screen (refer to 4-2 POWER-ON AND CRT CONTROL). Initialization is complete when they are displayed.

  b. When the memory card is being formatted

  c. When and immediately after the [SET REF] key is pressed

  d. When the REF memory number is updated by the rotary encoder

  e. When V MODE setting is changed (including REF ON/OFF selection)

  f. When a waveform is automatically stored into the REF memory by the AUTO ADVANCE function

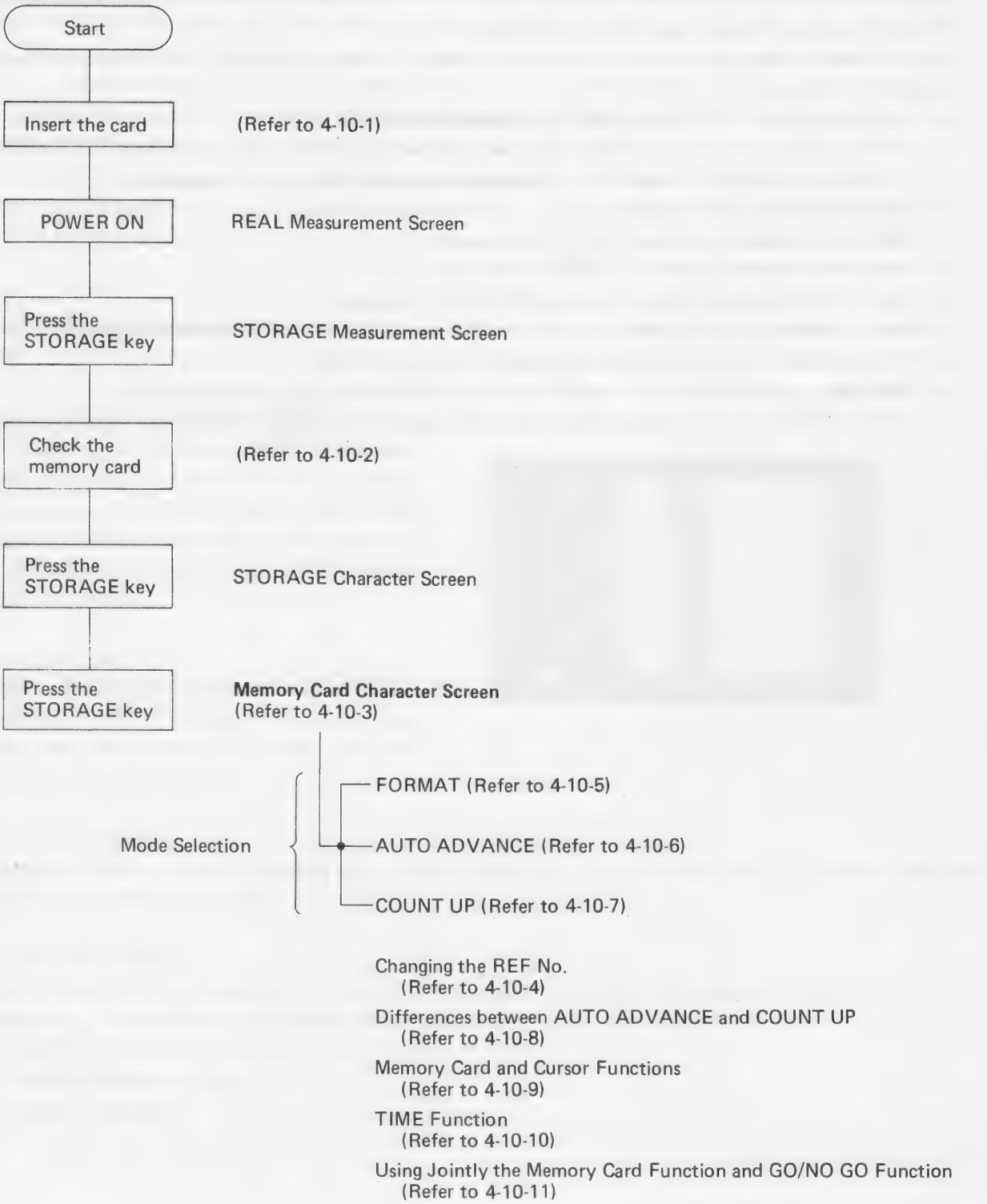
  g. When operation equivalent to those above is done in remote operation

  h. When data (waveform data, etc.) is being transferred to the memory card in remote operation

  i. Until the instrument is initialized and terminated after pressing the [LOCAL] (Index) key in the remote mode

Operation Guide

The following shows a flow chart for displaying the Memory Card Character Screen. Select a mode, using this Memory Card Character Screen.



4-10-1 Inserting the Card

Match a memory card guide mark with the guide mark (Δ) on the panel surface and insert the card. (Refer to Figs. 4-10-2 and 4-10-3)

Figure 4-10-2. Insertion of Card I

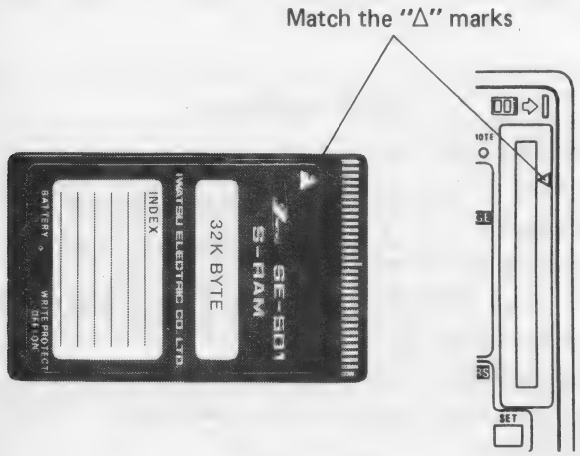
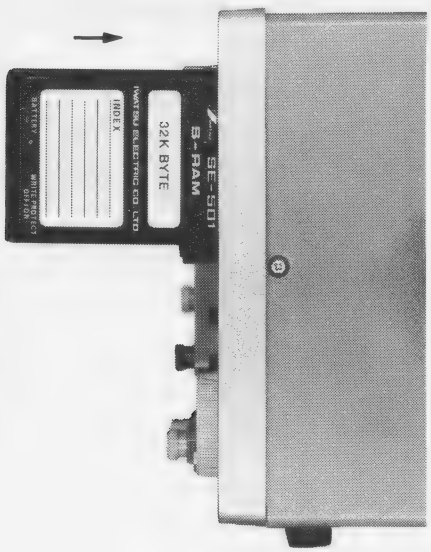


Figure 4-10-3. Insertion of Card II

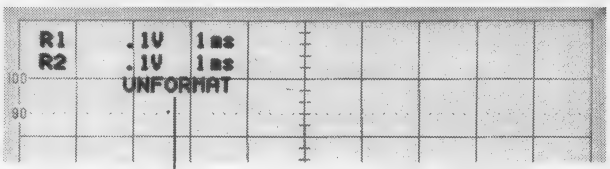


4-10-2 Checking the Memory Card

a. Whether the card has been formatted

Procedure

1. Turn on the POWER switch.
2. Press STORAGE .
   When the card has not been formatted, "UNFORMAT" is displayed on the upper left of the screen.



UNFORMAT Display

   Format the card in accordance with the procedure in 4-10-5.
3. When UNFORMAT is not displayed, proceed to the next check.

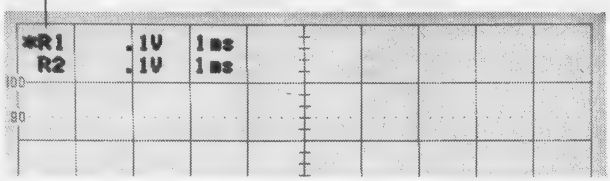
b. Whether the card is properly inserted

Procedure

1. Turn on the POWER switch.
2. Press STORAGE . "*Rn" is displayed on the upper left of the screen.

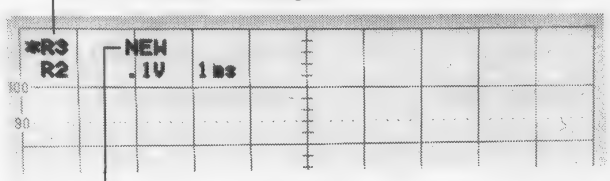
n : REF No.

Rn display with "*"



3. The "*Rn" number is changed by turning the rotary encoder. n : REF No.

This number is changed



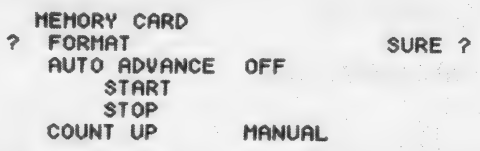
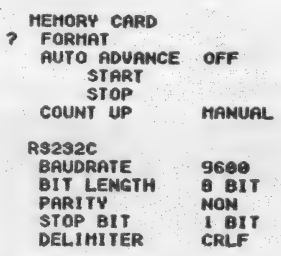
"NEW" is displayed when no waveform has been written after the memory card had been formatted.

4-10-3 Memory Card Character Screen

The screen is changed over as follows every time the [STORAGE] key is pressed.

REAL Screen → STORAGE Measurement Screen → STORAGE Character Screen → *1 MEMORY CARD Screen

Using the MEMORY CARD Screen, select the mode.

MEMORY CARD Screen	Operating Method
a. When AUTO ADVANCE is OFF  b. When AUTO ADVANCE is ON  *1 When RS-232C is installed, the RS-232C Character Screen is also displayed.  	Using the Index keys and rotary encoder, select mesuring conditions. • Index keys ([⇧] , [⇩]) Selects the item to be set. A "?" mark moves up by pressing [⇧] and moves down by pressing [⇩] . • Rotary encoder Specifies the item selected with the "?" mark. • [RUN/STOP] key For FORMAT: Performs formatting. For other than FORMAT: If this key is pressed, a LED is illuminated and a waveform is taken in.

Parameters for MEMORY CARD Screen

FORMAT	
AUTO ADVANCE	OFF, ON
START	3 ~ No. of waveform files of the memory card
STOP	3 ~ No. of waveform files of the memory card
COUNT UP	MANUAL, AUTO

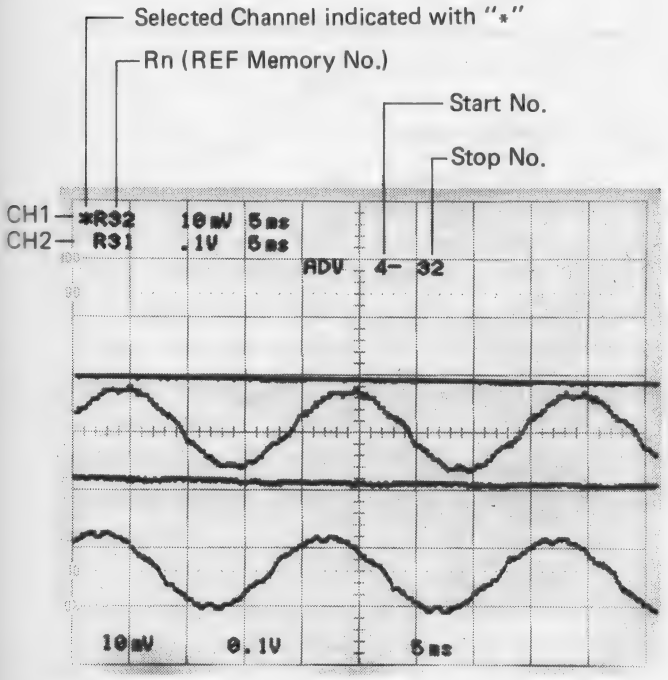
4-10-4 Changing the REF Memory No. (Rn)

Basically, a "*" mark indicates that the memory card function of the instrument is enabled. The REF Memory number on the channel with "*" mark can be changed with the rotary encoder.

This mark may not be displayed in the following cases, even if the memory card is properly inserted. If it happens, press [SET REF] just once.

a. When the memory card is inserted after POWER ON

b. When the cursor function is also used (refer to 4-10-9)

Measurement Screen	Operating Method
	• Index keys ([⇧] , [⇩]) Selects the channel. (when V MODE is DUAL) The "*" mark moves every time the Index key is pressed. [⇧] key CH1 → CH1 / CH2 → CH2 [⇩] key CH1 → CH2 → CH1 / CH2 • Rotary encoder Changes the REF memory number. This allows stored waveforms to be observed sequentially. Right turn . . . . . Count up Left turn . . . . . Count down • [SET REF] key Writes data into the memory card.

4-10-5 Formatting the Memory Card

A new (unused) memory card cannot be directly used. To use it in the instrument, it is necessary to format it in the following procedure.

The memory card used once enables previously stored data to be erased by reformatting it.

> **Caution**
>
> When the memory card is not inserted, or when the WRITE PROTECT switch is turned on even if it is inserted, it cannot be formatted.

Procedure

1. Set the "?" mark to FORMAT.

```
  MEMORY CARD
? FORMAT
  AUTO ADVANCE   OFF
      START
      STOP
  COUNT UP       MANUAL
```

2. Press [RUN/STOP] to display "SURE?".

```
  MEMORY CARD
? FORMAT                    SURE ?
  AUTO ADVANCE   OFF
      START
      STOP
  COUNT UP       MANUAL
```

3. Press [RUN/STOP]. "FORMATTING" is displayed momentarily and formatting is performed.

```
  MEMORY CARD
? FORMAT                    FORMATTING
  AUTO ADVANCE   OFF
      START
      STOP
  COUNT UP       MANUAL
```

4. Press [STORAGE] to display the Measurement Screen (STOP state).
5. a. When there is no Rn indicated with "*" on the upper left of the screen, press [SET REF].
   b. The card can be used when "*" is displayed.

If formatting is performed, the readout display on the upper left of the screen is turned to NEW until the next waveform is stored.

No REF waveform other than R1, R2 is displayed even if REF is set to ON. REF waveforms for R1 and R2 are displayed as a trace at the center of the screen.

4-10-6 AUTO ADVANCE

Every time a waveform is taken in, it is written automatically into the memory card. It is possible to specify memory numbers which start and stop, respectively.

Procedure

1. Set the "?" mark to AUTO ADVANCE.

```
  MEMORY CARD
   FORMAT
? AUTO ADVANCE   OFF
      START
      STOP
  COUNT UP       MANUAL
```

2. Set AUTO ADVANCE to ON.

```
  MEMORY CARD
   FORMAT
? AUTO ADVANCE   ON
      START      3
      STOP       3
  COUNT UP
```

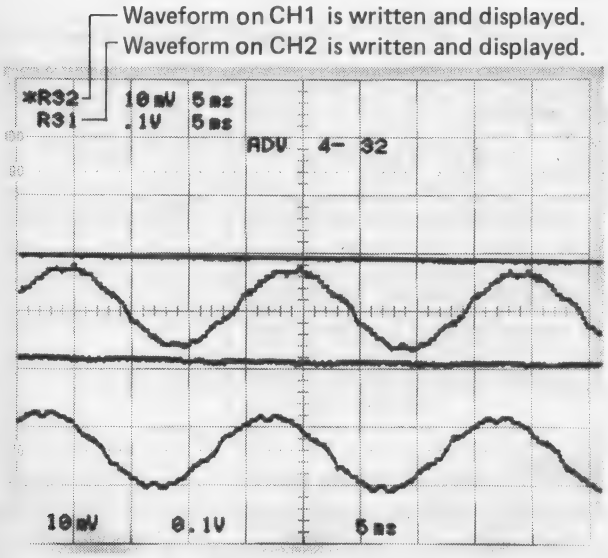
3. Set the "?" mark to START.
4. Set a reference memory start number.

```
  MEMORY CARD
   FORMAT
   AUTO ADVANCE  ON
     ? START     4
      STOP       32
  COUNT UP
```

5. Set a reference memory stop number in the same manner as in case of the start number.

```
  MEMORY CARD
   FORMAT
   AUTO ADVANCE  ON
      START      4
    ? STOP       32
  COUNT UP
```

6. Press [RUN/STOP] to display the Measurement Screen. Rn with "*" is displayed.
(Press [SET REF] if "*" is not displayed.)



7. AUTO ADVANCE is executed by pressing [SET REF] . If a waveform is taken according to V. MODE, it is written into the memory card. If the waveform is written into the memory card, a memory card number is automatically updated and the instrument enters waiting status for the next signal. Waveforms are repeatedly taken in and written up to the memory card stop number.

After the waveforms are taken in, the written waveforms can be sequentially observed by the rotary encoder.

CAUTION

When executing AUTO ADVANCE, be sure to set RUN/STOP to RUN.

Even in the RUN mode, automatic write is disabled in a signal waiting status with no trigger applied. Be careful of this in the NORMAL or SINGLE mode.

Interrupting AUTO ADVANCE

Press the [RUN/STOP] key to select the STOP mode.

AUTO ADVANCE resumes when the RUN mode is selected by pressing [RUN/STOP] again.

The file contents written halfway are held even if AUTO ADVANCE is interrupted.

Cancelling AUTO ADVANCE

Press the [STORAGE] key twice to display a character screen of the Memory Card and set AUTO ADVANCE to OFF on the menu.

The file contents written halfway are held even if AUTO ADVANCE is cancelled.

Saving the Stored Data

If [SET REF] is pressed after AUTO ADVANCE ends, the data stored so far are destroyed due to re-starting. To save the data stored in the memory card, follow one of the operations below:

a. Press [STOP] .
b. Cancel AUTO ADVANCE.
c. Turn on the WRITE PROTECT switch of the memory card.

REF No. Update and Waveform Stored

In the DUAL mode, REF numbers are updated alternately.

An input waveform for CH1 is written in the upper REF number.

An input waveform for CH2 is written in the lower REF number.

Example)
R3 → R5 → R7 → ..... Rn
R4 → R6 → R8 → Rn + 1
CH2
CH1

When the total number of REF memories from the start No. to stop No. is odd, data is written for CH1 only at the last.

Example) For ADV (AUTO ADVANCE)

(No. of files allowed: 7)

CH1 → R3 → R5 → R7 → R9
CH2 → R4 → R6 → R8 → R8

Only the R9 side takes in the CH1 waveform, and the R8 side does not retake.

4-10-7 COUNT UP

Procedure

1. Set the "?" mark to COUNT UP.

```
  MEMORY CARD
   FORMAT
   AUTO ADVANCE   OFF
        START
        STOP
 ?  COUNT UP       MANUAL
```

> **CAUTION**
>
> When AUTO ADVANCE is ON, COUNT UP cannot be set to ON. Set AUTO ADVANCE to OFF.
>
> ```
>   MEMORY CARD
>    FORMAT
> ?  AUTO ADVANCE   ON
>      START        3
>      STOP         3
>    COUNT UP
> ```
>
> Set AUTO ADVANCE to OFF.

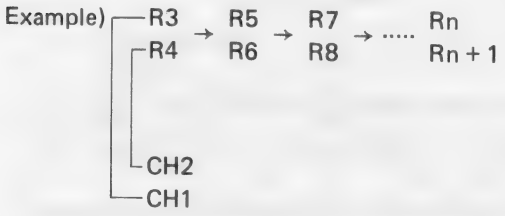
2. Either AUTO or MANUAL mode can be selected.

3. Press [RUN/STOP] to display the measurement screen.

4. Press [SET REF]. Data is written into the memory card.

- **AUTO**

Every time [SET REF] is pressed, a display waveform is filed into the REF memory and the REF number is updated endlessly.



- **MANUAL**

The REF number is not updated even if [SET REF] is pressed. The REF number is updated by the rotary encoder.

4-10-8 Differences Between AUTO ADVANCE and COUNT UP

Refer to Table 4-10-1.

Table 4-10-1

Mode	Waveform Writing	REF1/REF2 Setting & Writing	Write Timing	SET REF *1 Operation	REF No. Update
AUTO ADVANCE	Waveforms taken in are written into the REF memory one after another. If SET REF is pressed, data are stored in the memory card, automatically updating the REF numbers.	Disabled	When the waveform is taken in the CH1 or CH2.	Only once	Updated automatically up to the stop number.
COUNT UP (AUTO)	Of the waveforms taken in, only those required can be written. The REF numbers are updated by pressing SET REF .	Enabled	When SET REF is pressed	Required every time data is written	One by one
COUNT UP (MANUAL)	Waveform are taken in and written with the same REF number. The REF numbers are not updated by pressing SET REF .	Enabled	When SET REF is pressed	Required every time data is written	Not updated

1 This is based on the condition that "" is shown (memory card function selected) in the REF memory readout display on the upper left of the screen.

4-10-9 Memory Card Function and Cursor Function

Distinction on the Screen

The rotary encoder is used for both cursor function and memory card function. When both cursor function and memory card function are jointly used, you can tell for which function the rotary encoder is effective, by viewing Rn with "*" displayed on the upper left of the screen.

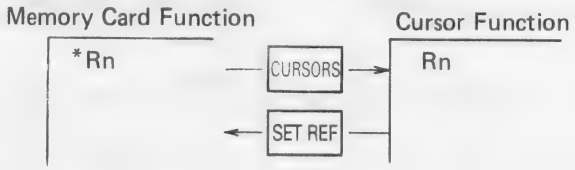
Memory card function: Rn with "*" is displayed on the upper left of the screen. The rotary encoder changes the REF numbers.

Cursor function: Rn without "*" is displayed on the upper left of the screen. The rotary encoder is used for selecting a measurement item.

Selecting the Memory Card Function/Cursor Function

Memory card function to cursor function : Press [CURSORS] .

Cursor function to memory card function : Press [SET REF] .



[Note] The memory card function cannot be selected unless a previously formatted memory card is inserted.

CAUTION

When the memory card function is working with the LED "CURSORS" illuminated, it is impossible to change the cursor function or move the cursor. Operate the cursor after selecting the cursor function.

Writing Cursor Measurement into the Memory Card

Procedure

1. Display the MEMORY CARD Screen.
2. Select the Memory Card mode.
3. Press [RUN/STOP] .
4. Press [SET REF] .

Precautions for Cursor and Delay Time Measurement

a. [SET REF]

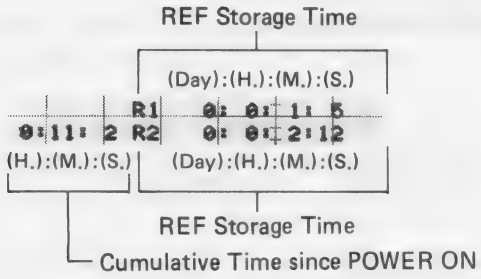
Although cursor measurement continues by pressing [SET REF] , the INDEX keys and rotary encoder are used for the memory card.

b. [CURSORS]

If [CURSORS] is pressed, the INDEX keys and rotary encoder are used for cursor measurement.

4-10-10 TIME Function

A real-time lock IC is incorporated. A cumulative time since POWER ON and a REF storage time are displayed on the bottom of the screen. Counting continues until power is turned off.



Procedure

1. Set the STORAGE mode to ON.
2. When displaying the REF storage time, set REF for V MODE to ON or display the REF number by inserting the memory card.
3. Press BEAM FIND. The time is displayed on the lower left of the screen.

The screen displays the time when the key is pressed and it remains unchanged until it is pressed again. (Internal time count advances.) Repress it as required.

Cumulative Time since POWER ON

The instrument displays a cumulative time (not data and time) since POWER ON.

REF Storage Time

A cumulative time since POWER ON when a waveform is stored in the REF memory is displayed.

Maximum Display Time

Cumulative time since POWER ON:

23 : 59 : 59
(H.) (M.) (S.)

Cumulative time since the data is stored in the REF memory:

31 : 23 : 59 : 59
(Day) (H.) (M.) (S.)

Maximum time controlled by the instrument = Maximum REF time

The TIME function continues even when the maximum time above is exceeded. However, time sequences are not assured.

Application

This function is effective when making measurement of GO/NO GO + AUTO ADVANCE.

For example, make setting so that only abnormal waveforms will be stored in the memory card by GO/NO GO + AUTO ADVANCE measurement. (Refer to GO/NO GO + AUTO ADVANCE.)

Even if there is a rare occurrence of abnormal waveforms, leave the instrument operating unattended and a NO GO waveform storage time can be read out later. Thus, you can know time intervals of abnormal waveform occurrences.

4-10-11 Jointly Using the Memory Card Function and GO/NO GO Function

Read "4-8-9 GO/NO GO" together with this subsection.

a. Storage of GO/NO GO Reference Waveforms and Judgment Criteria

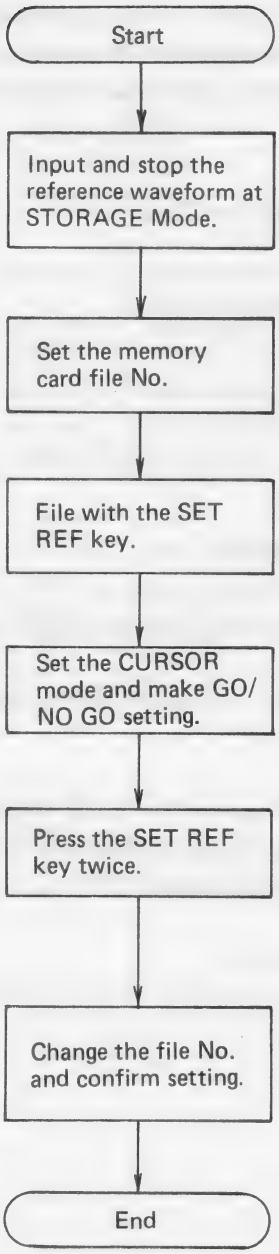
GO/NO GO reference waveforms and judgment criteria can be stored in the memory card. With this memory card used, the reference waveforms and judgment criteria can be recalled.

The following table shows relations between the waveforms judged and reference waveforms by V MODE.

V MODE	Waveform Judged	Reference Waveform
CH1	CH1	R1 ~ Rn
CH2	CH2	R1 ~ Rn
DUAL	CH1	R1 ~ Rn

CAUTION

- To determine a GO/NO GO judgment area, the reference waveform must be stored in the REF memory. So, it is necessary to write the reference waveform into a specified REF number once.
- Since GO/NO GO judgment criteria are filed simultaneously with REF waveforms, it is convenient if you stop an input waveform after taking in the reference waveform.



b. Joint Use with AUTO ADVANCE

Waveforms judged NO GO can be written into the file one after another by jointing using the GO/NO GO function and AUTO ADVANCE function (refer to their respective subsections).

Interruption/cancellation of AUTO ADVANCE: AUTO ADVANCE can be interrupted or cancelled even before waveforms are taken in as far as the stop number (refer to "4-10-6 AUTO ADVANCE").

CAUTION

- Do not enter the REF No. for the GO/NO GO reference waveform within the REF No. written by AUTO ADVANCE. If entered, the reference waveform is changed halfway.
- If SET REF is pressed by mistake after taking in waveforms up to the stop number by AUTO ADVANCE, the data taken in are erased due to a re-start. There are the following two methods to prevent this:
  a. Cancel AUTO ADVANCE.
  b. Turn on the WRITE PROTECT switch of the memory card.

MEMO

Section 5 GP-1B Interface

5-1 General

The instrument allows DS-504 (unit for GP-IB) to be attached to it.

When DS-504 is attached, an automatic measuring system can be easily configured by connecting to a personal computer, etc. which has the GP-IB interface.

Its electronical and mechanical specifications conform to IEEE Std. 488-1978.

5-1-1 Specifications of GP-IB

I/O signals

Input TTL level Active Low

Output TTL level Active Low

No. of units connected

Up to 15 units are connectable to one system.

Note: The "number of units connected" x 2 m should not exceed 20 m.

Cable length

A total cable length (2 m x number of units connected) should be within 20 m.

CAUTION

This instrument is to be used under conditions which are relatively good electrically and physically.

5-1-2 Construction

This instrument can be connected to an external controller (mini-computer, personal computer, etc.) or a plotter via GP-IB.

5-1-3 Interface Functions

Table 5-1-3 shows the interface functions of this instrument.

Table 5-1-3

Subset	Function	Description
SH1	Source handshake	Complete capability
AH1	Acceptor handshake	Complete capability
T5	Talker	Basic Talker, Serial poll, Talk Only Mode, Unaddress If MLA
TE0	Talker address extension	No capability
L4	Listener	Basic Listener, Unaddress If MTA, No Listen Only Mode
LE0	Listener address extension	No capability
SR1	Service request	Complete capability
RL2	Remote local	No local lock out
PP0	Parallel poll	No capability
DC1	Device clear	Complete capability
DT0	Device trigger	No capability
C0	Controller	No capability

5-2 INSTRUMENT INFORMATION

5-2-1 Address, Delimiter and Talk Only

a. Address and Delimiter

Address refers to the address of this instrument used by the remote function. The address of this instrument is used when a relevant controller specifies this instrument either as Talker or Listener.

The delimiter of this instrument is used to indicate an end of the data string, block or record transferred between a relevant controller and this instrument.

b. TALK ONLY Mode

The TALK ONLY mode is used when outputting a hard copy of the waveform on the screen to the plotter, etc. without using any controller.

When outputting to the plotter by remote control, send an Output command from the controller to this instrument, and next, specify "Talker".

c. Setting Method

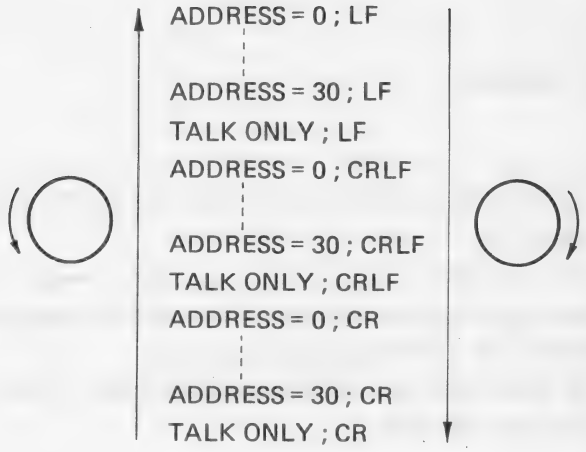
Set the address, delimiter and TALK ONLY mode on the Character screen in the STORAGE mode.

Procedure

① Set the "?" mark to GP-IB.

```
  STORAGE MODE * NORMAL
                 AVERAGE
                 PEAK CH HOLD
                 ROLL

       COUNT
       REPEAT    ON(0SEC)

  DATA LENGTH    1KW
  TIME BASE      INT
  EQU-SAMPLING   OFF
  INTERPOLATION  OFF
  SAVE           CH1
  DISPLAY
       CH1       INPUT
       CH2       INPUT

  OUTPUT         OFF
? GP-IB          ADDRESS=5;LF
```

② Using the rotary encoder, select the address and delimiter.



5-2-2 EOI Message

a. Output : It is output synchronously with the last one of the data to be output.

b. Input : It may be or may not be input.

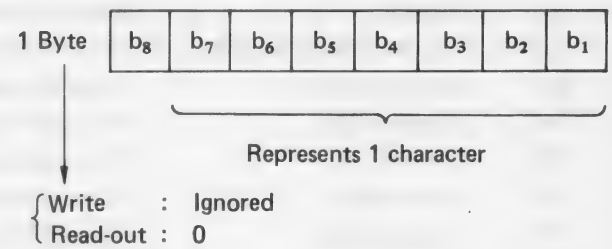
5-3 DATA CODES

The following codes are selectively used in order to represent the contents of data groups, etc. handled in GP-IB command or data transfer:

- ASCII code
- Binary code

a. ASCII Code

All of IS07 Bit Code

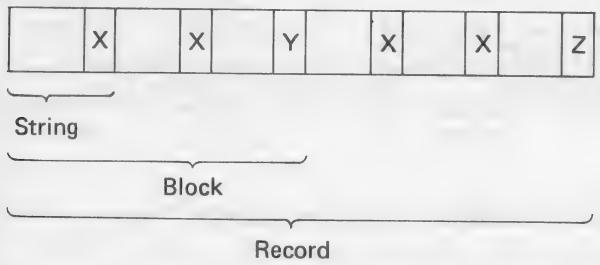


b. Binary Code

Data contents are shown in binary numbers.

5-4 DATA TRANSFER FORMAT

Data transferred on GP-IB consists of components; string, block and record.



X : String delimiter
Y : Block delimiter
Z : Record delimiter

String : Group of a series of data bytes which shows one value

Block : Group of strings which shows the same type

Recrod : Group of block (strings) to be transferred at one time

For this instrument, however, the block and record are equal to each other. To mark off the record, ASCII transfer format uses CR/LF/CRLF, and binary transfer format uses the number of bytes.

5-4-1 Strings by Transfer Type

Data transfer of this instrument includes waveform data input/output, SETUP input/output, auxiliary information output and cursor measured value output.

The following describes the strings for each transfer type.

Waveform Data Internal Representation

The internal representation of waveform data is treated as a signed 1 byte (2's complement).

A signed 1 byte (2's complement) is a representation which treats the upper most bit as a sign. The correspondence of a signed 1 byte and the screen is shown in Figure 5-4-1.

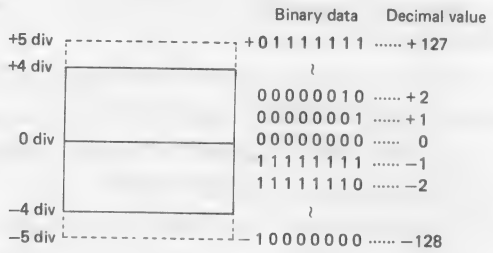
Vertical axis resolution: Approx. 10 div on screen is represented by 8 bits (236 steps); therefore, the resolution is 25 dots/1 div.

Horizontal axis display resolution: Approx. 10 div on screen is represented by 1 kw (1024); therefore, the resolution is 100 dots/1 div.

The value of sweeping range SEC/DIV is divided by 100 and the reciprocal of the resulting value is the sampling rate at that sweeping range. (However, DS-8606C: Max. 20 M samples/S) For 16 kw, the actual sampling rate of input result memory and SAVE memory is different from the one on display.

In that case, the value is ten times lager par 1 kw sampling rage. (However, DS-8606C: Max. 20 M samples/S)

Figure 5-4-1. Correspondence of a Signed 1 byte and the Screen



[Note] The broken lines stand for the area outside the screen.

Table 5-4-1

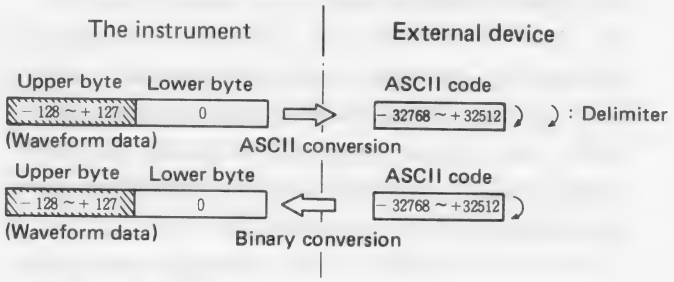
Item \ Format	Data Representation	No. of String Bytes	String Mark-off
Waveform data (ASCII)	ASCII code (with signed integer)	Input: Indefinite Output: Up to 6 bytes	Delimiter
Waveform (binary)	Binary value	2 bytes	2-byte data
SETUP and waveform collateral information	ASCII code (with signed integer)	Input: Indefinite Output: Up to 6 bytes	Delimiter
Auxiliary information	Combination of ASCII code	Up to 10 bytes	Delimiter
Cursor measured value	Combination of ASCII code	Up to 11 bytes	Delimiter
Status sense	ASCII code	1 byte	Delimiter

Waveform Data Format

a. ASCII Code Type

In order to match with binary code type, transfer is made as a decimally converted value of signed 16 bits which has 1 byte of waveform data as the upper bit and 0 (00H) attached to the lower bit. In other words, −32768 ~ +32512, which is simply −128 ~ +127 times 256, is converted to ASCII code and transferred. Each data is divided by a delimeter.

When matching with the internal data in this unit after transferring data to a computer, etc., simply divide each data by 256 to obtain a value of −128 ~ +127.

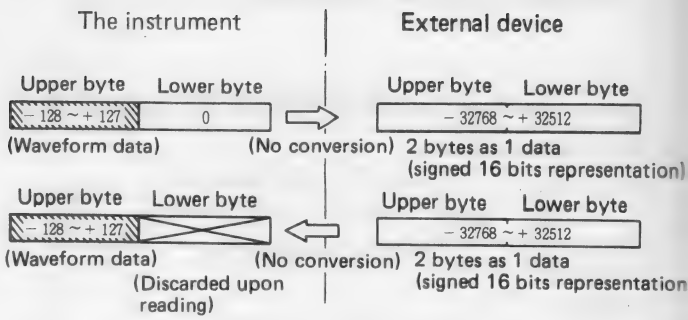


b. Binary Code Type

One byte of the waveform data is set to the upper byte and 0 (00H) is set to the lower byte. Those two bytes are transferred as one data. No delimiter is between the data.

The upper byte is transferred first and the lower byte next.

- When the data is transferred to a computer, etc., it is treated as signed 16 bits 1 data and if each data is divided by 256 after transfer, it can be matched with the internal data of this unit (−128 ~ +127).
- There is another way: the computer discards the lower byte, reading the upper byte only. In this case, however, the computer often fails to treat directly 1 data as signed 8 bits and the read value becomes 0 ~ 256. In order to match the waveform data thus read by a computer with the internal data of this unit, simply subtract 256 (80H) when each data is more than 128. Then, the data can be converted to the value of −128 ~ +127. (Refer to "6-4-1 PC-9801".)



5-4-2 Transfer Format by Transfer Type

The following provides detailed descriptions on transfer formats by transfer type:

a. Input/Output of Waveform Data

- ASCII type transfer

  d_1 ❯ d_2 ❯ d_3 ❯ ..... ❯ dn ❯

  dn : Data (ASCII)

- Binary type transfer

  d_1 d_1' d_2 d_2' ..... dn dn'

  dn dn' : Data (2 bytes/1w)

  dn' (lower byte) is always "0".

b. Input/Output of SETUP and Waveform Collateral Information

d_1 ❯ d_2 ❯ d_3 ❯ ..... dn

dn : Data (ASCII)

c. Output of Auxiliary Information

c_1 ❯ d_1 ❯ c_2 ❯ d_2 ❯ ..... c_7 ❯ d_7 ❯

c_1 : Identification code
d_1 : Data
} ASCII code

d. Output of Cursor Measured Value

e ❯ d_1 ❯ d_2 ❯ d_3 ❯ ..... dn ❯

e : No. of data (n)
dn : Data
} ASCII code

e. Output of Status Sense

d_1 ❯ d_2 ❯ d_3

d_1 : RUN status
d_2 : GO/NO GO judgment
d_3 : Waveform input status
} ASCII code

5-4-3 Various Calculation Methods from Waveform Data

(1) Obtaining the voltage value of the point-to-point data

1. Convert the waveform data of 2 points into the values of −128 through +127. (Refer to 5-4-1 Strings by Transfer Type)
2. A point-to-point voltage value is obtained by the following expression.

$$\text{Voltage value} = \frac{(\text{Waveform data 1} - \text{Waveform data 2}) \times (\text{VOLTS/div})}{25}$$

- Waveform data 1 and waveform data 2:
  Values of −128 through +127 obtained in the step 1
- VOLTS/div:
  VOLTS/div value obtained from the No. 13 parameter for the waveform collateral information corresponding to the waveform data.
- 25:
  Number of dots per 1 div.

(Example)

Obtaining the point-to-point voltage value in the CH1 waveform data

CH1 waveform data 1 : +44
CH2 waveform data 2 : −56
Wavefrom collateral information No. 13 for D10 : +4

Voltage value
= [(+44) − (−56)] x 50 mV ÷ 25 = 200 mV

(2) Obtaining the true voltage value (allowed for DS-8606/C only)

Note: Before measuring a waveform, be sure to take in a GND value, using the GND REFERENCE function.
(Refer to 4-8-6 GND REFERENCE or 6-3 Details of Commands, (21) Cursor Measurement, and (25) GND Setting in the Instruction Manual)

1. Convert the waveform data, whose voltage value you want to obtain, into the value of −128 through +127.
   (Refer to 5-4-1 Strings by Transfer Type)
2. Obtain the true voltage value by the following expression.

$$\text{Voltage value} = \frac{(\text{Waveform data} - \text{GND value}) \times (\text{VOLTS/div})}{25}$$

- Waveform data:
  Value of −128 through +127 obtained in the step 1
- GND value:
  (Value of waveform collateral information No.7) −128 for CH1 INPUT, CH2 INPUT, CH1 SAVE, or CH2 SAVE
  (Value of waveform collateral information No.7) −128 for REF1 through REF122
- VOLTS/div:
  VOLTS/div value obtained from the No. 13 parameter for the waveform collateral information corresponding to the waveform data
- 25:
  Number of dots per 1 div

(Example)

Obtaining the voltage value of a certain point in the CH2 waveform data

CH1 waveform data 1: +44
- Waveform collateral information No. 7 for D11: +135
- Waveform collateral information No. 136 for D11: +6

Conversion of the GND value
GND value = (+135) − 128 = +7

Voltage value
= [(+44) − (+7)] x 0.2V ÷ 25 = 0.296 V

(3) Calculating the true time relationship between data

SEC/div corresponding to the *No.11 or No. 12 parameter of the waveform collateral information

↓

$$\frac{\text{Current SEC/div}}{100} \times (\text{Address difference between data})$$

↑

1 div = 100 data

With this expression, you can obtain the true time relationship between data.

Use No. 12 for *CH1 INPUT, CH2 INPUT, CH1 SAVE, and CH2 SAVE.

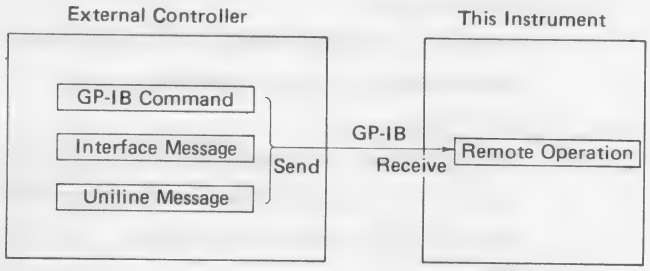
Use No. 11 for REF1 through REF122.

5-5 REMOTE OPERATIONAL FUNCTIONS

5-5-1 General

This instrument can be remotely operated from the external controller via GP-IB.

Remote operation is done based on a combination of GP-IB command, interface message and uniline message (IFC, REN, ATN).



Remote operational functions are classified into the following detailed functions:

- Panel operation
- Data transfer
- Status output
- Control message response

5-5-2 Panel Operation

Part of panel operation of this instrument can be done with GP-IB commands from the external controller.

The following shows details of panel operation which can be remotely controlled:

- REAL
- STORAGE
  - STORAGE MODE { NORM / AVERAGE / PEAK CH HOLD / ROLL }
  - DATA LENGTH
  - TIME BASE
  - EQU-SAMPLING
  - INTERPOLATION
  - SAVE
  - DISPLAY
  - OUTPUT
- STORE REF
- RUN/STOP
- CURSORS & DELAY { ΔVOLTAGE / ΔTIME / VOLTAGE RATIO / PHASE / GND REFERENCE / PEAK TO PEAK / MAX & MIN / GO/NO GO / DELAY TIME / DATA POSITION / DISP. SCROLL }
- SET (GND level setting)
- V MODE
- HORIZ DISPLAY
- A SEC/DIV
- B SEC/DIV
- SWEEP MODE
- SINGLE RESET
- A TRIGGER SOURCE
- B TRIGGER SOURCE
- TRIGGER COUPLING
- TRIGGER SLOPE
- MEMORY CARD { AUTO ADVANCE / FORMAT / STORE / RECALL }

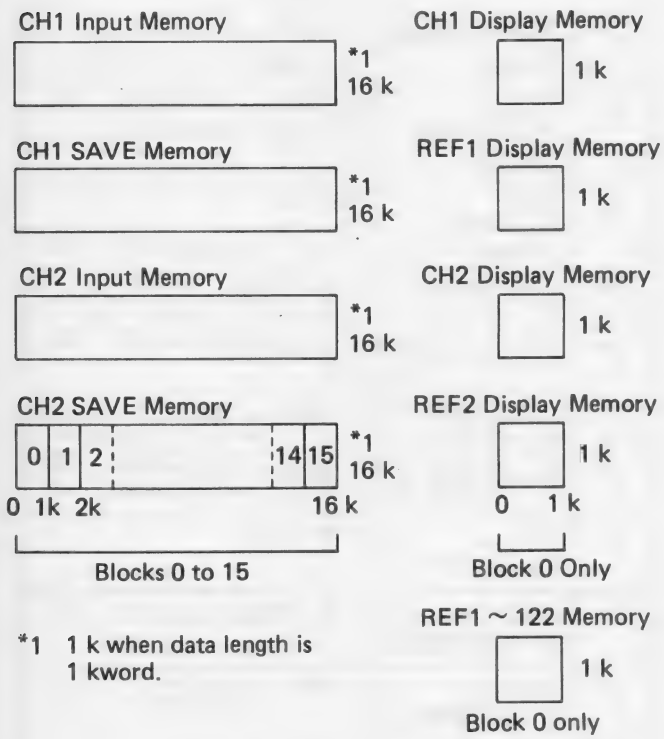
5-5-3 Data Transfer

The instrument provides input/output of waveform data, SETUP data and waveform collateral information, and output of auxiliary information, cursor measured value and status sense.

a. Reading out and Writing the Waveform Data

Reading-out and writing of waveform data are available for each of input memories (CH1, CH2, CH1 SAVE, CH2 SAVE) and each of display memories (CH1, CH2, REF1, REF2, REF1 ~ 122). Either ASCII or binary transfer is selectable. (The data in a memory card is transferrable.)

For the number of transfer data (data length), you can select one of 1 k, 2 k, 4 k, 8 k and 16 k and specify a transfer block by the unit of 1 k.



*1 1 k when data length is 1 kword.

[Note 1] When the data length is 16 kw, no writting can be made into CH1/CH2 input memories.

[Note 2] The input result waveform entered in the ROLL mode is stored in the input memory (data length always 1 kw).

When it is input in the AVERAGE or PEAK CH HOLD mode, an input result of data length is 1 kw, even if its data length input is 16 kw.

Waveform collateral information indicates a length of 16 kw in this case.

b. Reading out and Writing the SETUP Data

You can collectively perform setting and reading-out as to remotely controllable panel keys.

SETUP Information

When sending from the host to the instrument (IX — S): 1 to 52 (52 data)

When sending from the instrument to the host (JX — S): 1 to 63 (63 data)

Order	Item	Parameter
1	REAL/ STORAGE	0 : REAL 1 : STORAGE
2	Measurement Mode	1 : STORAGE NORMAL 2 : AVERAGE 3 : PEAK CH HOLD 4 : ROLL
3	COUNT	1 : 2 times 2 : 4 times 3 : 8 times 4 : 16 times 5 : 32 times 6 : 64 times 7 : 128 times 8 : 256 times FFH : ∞
4	REPEAT	0 : OFF 1 : ON (0SEC) 2 : ON (1SEC) 3 : ON (2SEC)
5	DATA LENGTH	0 : 1Kword 1 : 16Kword
6	TIME BASE	0 : INT 1 : EXT
7	EQU SAMPLE	0 : OFF 1 : ON
8	INTER POLATION	0 : OFF 1 : LINEAR 2 : SINE
9	DISPLAY CH1	0 : INPUT 1 : SAVE
10	DISPLAY CH2	0 : INPUT 1 : SAVE
11	OUTPUT	0 : OFF 1 : PEN 2 : PLOT
12	Output Type (PEN)	0 : CAL 1 : SCALE 2 : WAVEFORM 3 : SCALE + WAVEFORM
13	△VOLTAGE	0 : OFF 1 : ON
14	△TIME	0 : OFF 1 : ON
15	VOLTAGE RATIO	0 : OFF 1 : ON
16	PHASE	0 : OFF 1 : ON
17	GND REFERENCE	0 : OFF 1 : ON
18	PEAK TO PEAK	0 : OFF 1 : ON
19	MAX & MIN	0 : OFF 1 : ON
20	GO/NO GO	0 : OFF 1 : ON
21	DELAY TIME Setting	0 : OFF 1 : ON
22	DATA POSITION Setting	0 : OFF 1 : ON
23	DISP ADDRESS Setting	0 : OFF 1 : ON
24	V-CURSOR I	0 to 4095
25	V-CURSOR II	0 to 4095
26	H-CURSOR I	− 2048 to 2047
27	H-CURSOR II	− 2048 to 2047
28	Ref. V-CURSOR I	0 to 4095
29	Ref. V-CURSOR II	0 to 4095
30	Ref. H-CURSOR I	− 2048 to 2047
31	Ref. H-CURSOR II	− 2048 to 2047
32	REF Waveform Width	0 to 255
33	GND LEVEL CH1	0 to 255
34	GND LEVEL CH2	0 to 255

Order	Item	Parameter
35	DELAY TIME	0 to 4095
36	DATA POSITION	0 to 10
37	DISP ADDRESS	0 to 16383
38	V-MODE	1 : CH1 2 : CH2 3 : ADD 4 : DUAL 5 : TRI 6 : X-Y
39	ALT/CHOP (REF ON/ OFF)	0 : ALT (REF OFF) 1 : CHOP (REF ON)
40	TRIGGER SORCE	1 : CH1 2 : CH2 3 : CH3 4 : LINE
41	TRIGGER COUPLING	1 : AC 2 : HF REJ 3 : DC 4 : TV
42	TRIGGER SLOPE	0 : + 1 : −
43	SWEEP MODE	1 : AUTO 2 : NORM 3 : SINGLE
44	HORIZ DISPLAY	1 : A 2 : A INTEN 3 : B 4 : ALT
45	RUNS AFTER/ TRIG'D	0 : RUNS AFTER 1 : TRIG'D
46	A SEC/DIV	1 : 0.5 s/div 2 : 0.2 s/div 3 : 0.1 s/div 4 : 50 ms/div 5 : 20 ms/div 6 : 10 ms/div 7 : 5 ms/div 8 : 2 ms/div 9 : 1 ms/div 10 : 0.5 ms/div 11 : 0.2 ms/div 12 : 0.1 ms/div 13 : 50 μs/div

Order	Item	Parameter
46		14 : 20 μs/div 15 : 10 μs/div 16 : 5 μs/div 17 : 2 μs/div 18 : 1 μs/div 19 : 0.5 μs/div 20 : 0.2 μs/div 21 : 0.1 μs/div 22 : 50 n s/div
47	B SEC/DIV	4 : 50 ms/div 5 : 20 ms/div 6 : 10 ms/div 7 : 5 ms/div 8 : 2 ms/div 9 : 1 ms/div 10 : 0.5 ms/div 11 : 0.2 ms/div 12 : 0.1 ms/div 13 : 50 μs/div 14 : 20 μs/div 15 : 10 μs/div 16 : 5 μs/div 17 : 2 μs/div 18 : 1 μs/div 19 : 0.5 μs/div 20 : 0.2 μs/div 21 : 0.1 μs/div 22 : 50 n s/div
48	AUTO ADVANCE	0 : OFF 1 : ON
49	START	3 to 122
50	STOP	3 to 122
51	File No. for REF1 Display	1 to 122
52	File No. for REF2 Display	1 to 122
53	PROBE CH1	0 : 10 : 1 Without probe 1 : 10 : 1 With probe
54	PROBE CH2	0 : 10 : 1 Without probe 1 : 10 : 1 With probe
55	VARIABLE CH1	0 : CAL 1 : UNCAL
56	VARIABLE CH2	0 : CAL 1 : UNCAL

Order	Item	Parameter
57	CH2 POLARITY	0 : OFF 1 : ON
58	× 5MAG CH1	0 : OFF 1 : ON
59	× 5MAG CH2	0 : OFF 1 : ON
60	VOLTS/DIV CH1	1 : 5 mV/div 2 : 10 mV/div 3 : 20 mV/div 4 : 50 mV/div 5 : 0.1 V/div 6 : 0.2 V/div 7 : 0.5 V/div 8 : 1 V/div 9 : 2 V/div 10 : 5 V/div 11 : 10 V/div
61	VOLTS/DIV CH2	1 : 5 mV/div 2 : 10 mV/div 3 : 20 mV/div 4 : 50 mV/div 5 : 0.1 V/div 6 : 0.2 V/div 7 : 0.5 V/div 8 : 1 V/div 9 : 2 V/div 10 : 5 V/div 11 : 10 V/div
62	× 10MAG	0 : OFF 1 : ON
63	A VARIABLE	0 : CAL 1 : UNCAL

c. Reading out and Writing the Waveform Collateral Information

To the memory which allows waveform data to be read out and written, its collateral information can be read out and written. (Collateral information related to the CH1 and CH2 display memories are nothing.) .)

Details of Waveform Collateral Information

For CH1 INPUT (D10), CH2 INPUT (D11), CH1 SAVE (D12), and CH2 SAVE (D13) . . . . . 18 data

Order	Item	Parameter
1	Input Waveform Measurement Mode	1 : STORAGE NORMAL 2 : AVERAGE 3 : PEAK CH HOLD 4 : ROLL
2	COUNT Set Values of Input Waveform (AVERAGE, PEAK CH HOLD)	1 : 2 times 2 : 4 times 3 : 8 times 4 : 16 times 5 : 32 times 6 : 64 times 7 : 128 times 8 : 256 times FFH : ∞
3	Input Waveform Take-in times	0 to 999
4	Data Length of Input Waveform	0 : 1kword 1 : 16kword
5	TIME BASE of Input Waveform	0 : INT 1 : EXT
6	EQU SAMPLE of Input Waveform	0 : OFF 1 : ON
*1 7	GND LEVEL of Input Waveform	0 to 255
8	DELAY TIME of Input Waveform	0 to 4095
9	DATA POSITION of Input Waveform	0 to 10
10	HORIZ DISP of Input Waveform	1 : A 2 : A INTEN 3 : B 4 : ALT

Order	Item	Parameter	
		NORMモード	ROLLモード
*2 11	SEC/DIV of Input Waveform	1 : 0.5 s/div	500s/div
		2 : 0.2 s/div	200s/div
		3 : 0.1 s/div	100s/div
		4 : 50ms/div	50s/div
		5 : 20ms/div	20s/div
		6 : 10ms/div	10s/div
		7 : 5ms/div	5s/div
		8 : 2ms/div	2s/div
		9 : 1ms/div	1s/div
		10: 0.5ms/div	0.5s/div
		11: 0.2ms/div	0.2s/div
		12: 0.1ms/div	0.1s/div
		13: 50 μs/div	0.1s/div
		14: 20 μs/div	0.1s/div
		15: 10 μs/div	0.1s/div
		16: 5 μs/div	0.1s/div
		17: 2 μs/div	0.1s/div
		18: 1 μs/div	0.1s/div
		19: 0.5 μs/div	0.1s/div
		20: 0.2 μs/div	0.1s/div
		21: 0.1 μs/div	0.1s/div
		22: 50ns/div	0.1s/div
		NORM Mode	ROLL Mode
*2 12	Real Sweep Time of Input Waveform	1 : 0.5 s/div	500s/div
		2 : 0.2 s/div	200s/div
		3 : 0.1 s/div	100s/div
		4 : 50ms/div	50s/div
		5 : 20ms/div	20s/div
		6 : 10ms/div	10s/div
		7 : 5ms/div	5s/div
		8 : 2ms/div	2s/div
		9 : 1ms/div	1s/div
		10 : 0.5ms/div	0.5s/div
		11 : 0.2ms/div	0.2s/div
		12 : 0.1ms/div	0.1s/div
		13 : 50 μs/div	0.1s/div
		14 : 20 μs/div	0.1s/div
		15 : 10 μs/div	0.1s/div
		16 : 5 μs/div	0.1s/div
		17 : 2 μs/div	0.1s/div
		18 : 1 μs/div	0.1s/div
		19 : 0.5 μs/div	0.1s/div
		20 : 0.2 μs/div	0.1s/div
		21 : 0.1 μs/div	0.1s/div
		22 : 50ns/div	0.1s/div
13	VOLTS/DIV of Input Waveform	1 : 5mV/div	
		2 : 10mV/div	
		3 : 20mV/div	
		4 : 50mV/div	
		5 : 0.1 V/div	
		6 : 0.2 V/div	
		7 : 0.5 V/div	
		8 : 1 V/div	
		9 : 2 V/div	
		10 : 5 V/div	
		11 : 10 V/div	

Order	Item	Parameter
14	VARIABLE of Input Waveform	0 : CAL 1 : UNCAL
15	PROBE State of Input Waveform	0 : 10 : 1 Without probe 1 : 10 : 1 With probe
16	×5 MAG of Input Waveform	0 : OFF 1 : ON
17	A VARIABLE of Input Waveform	0 : CAL 1 : UNCAL
18	Dummy (CH2 Polarity for CH2)	0 [0 : OFF 1 : ON]

*1 Written into GND LEVEL of the waveform collateral information for CH1 INPUT and CH2 INPUT is the GND value existion when previous GND REFERENCE is executed. (A default value is 128)

When SAVE is executed, the GND LEVEL values of the CH1 INPUT and CH2 INPUT are copied to GND LEVEL of the waveform collateral information for CH1 INPUT and CH2 INPUT, as they are.

*2 SEC/DIV of the No. 11 input waveform indicates the sweep range when the waveform is taken in.

The real sweep time for the No. 12 input waveform indicates the sweep range corresponding to the sampling rate.

The actual sampling rate can be obtained out of the value of No. 12, using the following expression.

100/No. 12 sweep range value

Esample) Value of No. 12 : 16

Sampling rate : 100/5 μs = 20 Msps

In case of equivalent sampling, an equivalent sampling rate results.

Normally the value of No. 11 and that of No. 12 match each other, but, when a waveform is taken in at 2 μs/div to 50 ns/div in the NORM storage mode, the following results:

Value of No.11: Sweep range (17 to 22) when taken in

Value of No.12: Fixed at 5 μs/div (16)

Datails of Waveform Collateral Information

For REF1 display (D22), REF2 display (D23), and REF1 (1001) to REF122 (1122).

Order	Item	Parameter
1	Input Waveform Measurement Mode	1 : STORAGE NORMAL 2 : AVERAGE 3 : PEAK CH HOLD 4 : ROLL
2	COUNT Set Values of Input Waveform (AVERAGE, PEAK CH HOLD)	1 : 2 times 2 : 4 times 3 : 8 times 4 : 16 times 5 : 32 times 6 : 64 times 7 : 128 times 8 : 256 times FFH : ∞
3	Display Waveform Take-in Times	0 to 999
4	TIME BASE of Display Waveform	0 : INT 1 : EXT
5	EQU SAMPLE of Display Waveform	0 : OFF 1 : ON
*1 6	GND LEVEL of Display Waveform	0 to 255
7	INTER-POLATION of Display Waveform	0 : OFF 1 : LINEAR 2 : SINE
8	DELAY TIME of Display Waveform	0 to 4095
9	DATA POSITION of Display Waveform	0 to 10
10	HORIZ DISP of Display Waveform	1 : A 2 : A INTEN 3 : B 4 : ALT
*2 11	SEC/DIV of Display Waveform	NORM Mode / ROLL Mode 1 : 0.5 s/div / 500s/div 2 : 0.2 s/div / 200s/div 3 : 0.1 s/div / 100s/div 4 : 50ms/div / 50s/div 5 : 20ms/div / 20s/div 6 : 10ms/div / 10s/div 7 : 5ms/div / 5s/div 8 : 2ms/div / 2s/div 9 : 1ms/div / 1s/div 10 : 0.5ms/div / 0.5s/div 11 : 0.2ms/div / 0.2s/div 12 : 0.1ms/div / 0.1s/div 13 : 50 μs/div / 0.1s/div 14 : 20 μs/div / 0.1s/div 15 : 10 μs/div / 0.1s/div
11		NORM Mode / ROLL Mode 16 : 5 μs/div / 0.1s/div 17 : 2 μs/div / 0.1s/div 18 : 1 μs/div / 0.1s/div 19 : 0.5 μs/div / 0.1s/div 20 : 0.2 μs/div / 0.1s/div 21 : 0.1 μs/div / 0.1s/div 22 : 50ns/div / 0.1s/div
*2 12	Real Sweep Time of Display Waveform	NORM Mode / ROLL Mode 1 : 0.5 s/div / 500s/div 2 : 0.2 s/div / 200s/div 3 : 0.1 s/div / 100s/div 4 : 50ms/div / 50s/div 5 : 20ms/div / 20s/div 6 : 10ms/div / 10s/div 7 : 5ms/div / 5s/div 8 : 2ms/div / 2s/div 9 : 1ms/div / 1s/div 10 : 0.5ms/div / 0.5s/div 11 : 0.2ms/div / 0.2s/div 12 : 0.1ms/div / 0.1s/div 13 : 50 μs/div / 0.1s/div 14 : 20 μs/div / 0.1s/div 15 : 10 μs/div / 0.1s/div 16 : 5 μs/div / 0.1s/div 17 : 2 μs/div / 0.1s/div 18 : 1 μs/div / 0.1s/div 19 : 0.5 μs/div / 0.1s/div 20 : 0.2 μs/div / 0.1s/div 21 : 0.1 μs/div / 0.1s/div 22 : 50ns/div / 0.1s/div
13	VOLTS/DIV of Input Waveform	1 : 5mV/div 2 : 10mV/div 3 : 20mV/div 4 : 50mV/div 5 : 0.1 V/div 6 : 0.2 V/div 7 : 0.5 V/div 8 : 1 V/div 9 : 2 V/div 10 : 5 V/div 11 : 10 V/div
14	VARIABLE of Display Waveform	0 : CAL 1 : UNCAL
15	PROBE State of Display Waveform	0 : 10 : 1 Without probe 1 : 10 : 1 With probe
16	×5 MAG of Display Waveform	0 : OFF 1 : ON
17	A VARIABLE of Display Waveform	0 : CAL 1 : UNCAL

Order	Item	Parameter
18	Display Start Address	0 to 1023
19	Display End Address	0 to 1023
20	Dummy (CH2 Polarity for CH2)	0 [0 : OFF 1 : ON]
21	V CURSOR I for GO/NO GO	0 to 4095
22	V CURSOR II for GO/NO GO	0 to 4095
23	REF Waveform width for GO/NO GO	0 to 255
24	REF Acquisition Day	0 to 31
25	REF Acquisition Hours	0 to 23
26	REF Acquisition Minutes	0 to 59
27	REF Acquisition Seconds	0 to 59

*1 When SET REF is executed, the GND LEVEL valuses of the waveform collateral information for CH1 INPUT and CH2 INPUT are copied to GND LEVEL of the waveform collateral information for REF1 display, REF2 display, and REF1 to REF2, respectively.

*2 SEC/DIV of No. 11 display waveform indicates the sweep range displayed on the screen as to REF1 display, REF2 display, and REF1 to REF122. It indicates the sweep range effective when the waveform is taken in.

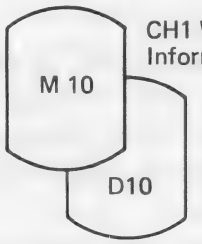
The real sweep time of the No. 12 display waveform represents the sweep time existing when the waveform is taken in first.

Therefore, when the waveform taken in in the CH1 INPUT mode, CH2 INPUT mode, etc. is enlarged horizontally and stored in the REF memory, No. 11 and No. 12 have different values.

Example) When the waveform taken in at 1 ms/div is enlarged horizontally up to 0.1 ms/div and stored in the REF memory;
Value of No. 11 : 12 (0.1 ms/div)
Value of No. 12 : 9 (1 ms/div)

The following describes the files handled by IX and JX commands.

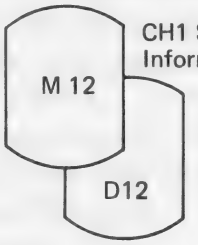
CH1 Input Memory File (CH1 INPUT)



CH1 Waveform Collateral Information File

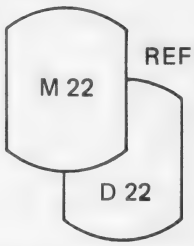
CH1 Display Memory File (only for JX)

CH1 SAVE Memory File



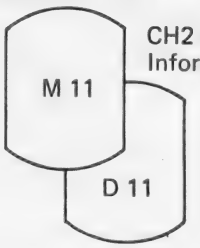
CH1 SAVE Collateral Information File

REF1 Display Memory File



REF1 Display Memory Collateral Information File

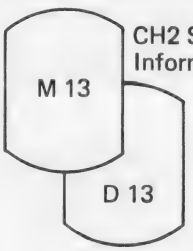
CH2 Input Memory File (CH2 INPUT)



CH2 Waveform Collateral Information File

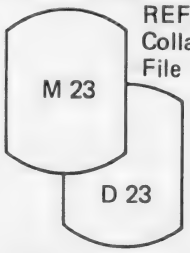
CH2 Display Memory File (only for JX)

CH2 SAVE Memory File



CH2 SAVE Collateral Information File

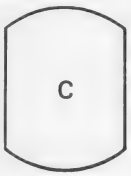
REF2 Display Memory File



REF2 Display Memory Collateral Information File

SETUP File

Cursor Measurement Result File

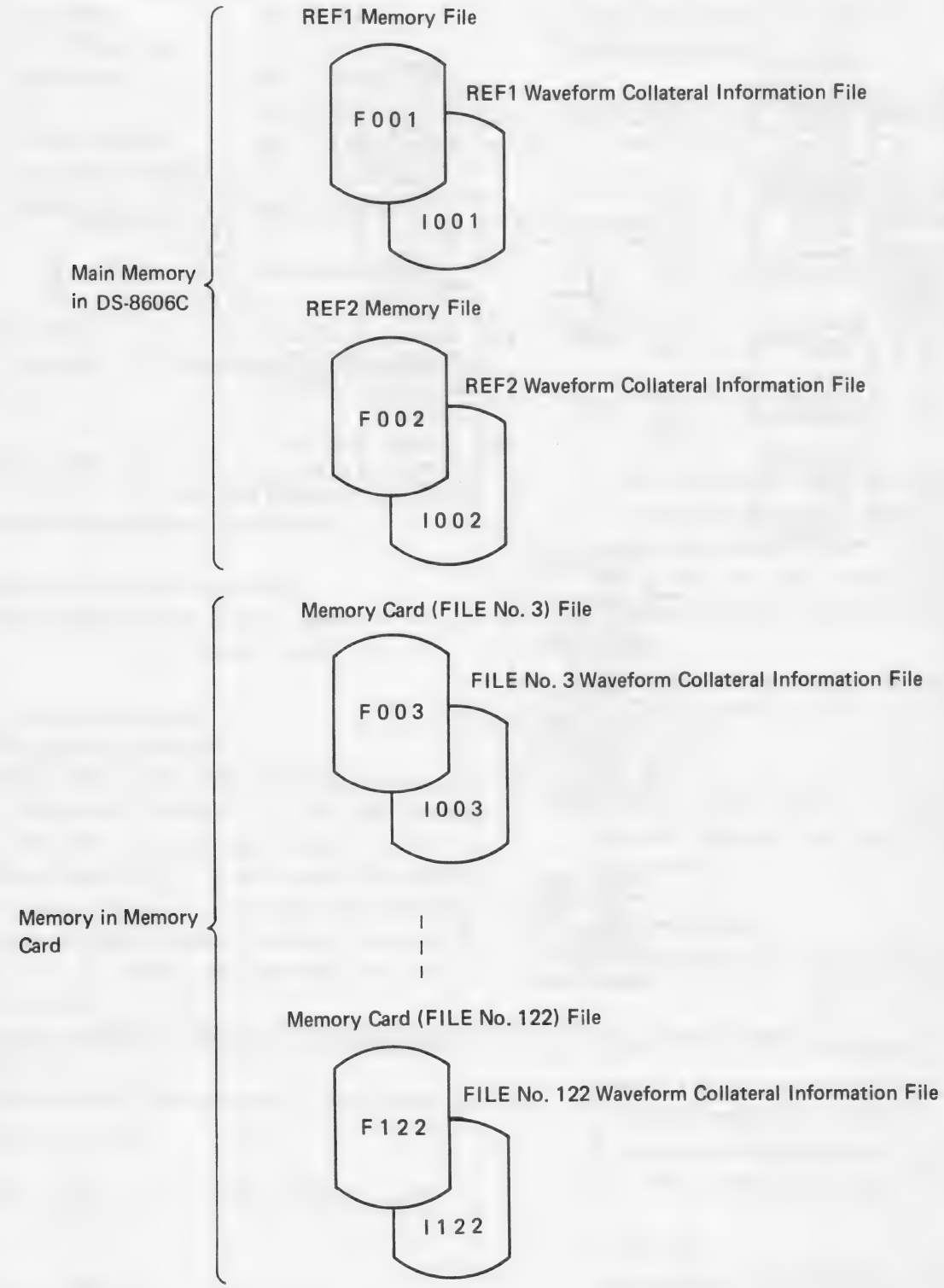


Status Sense File

Increase of files by memory card

Files can be increased by adding a memory card.

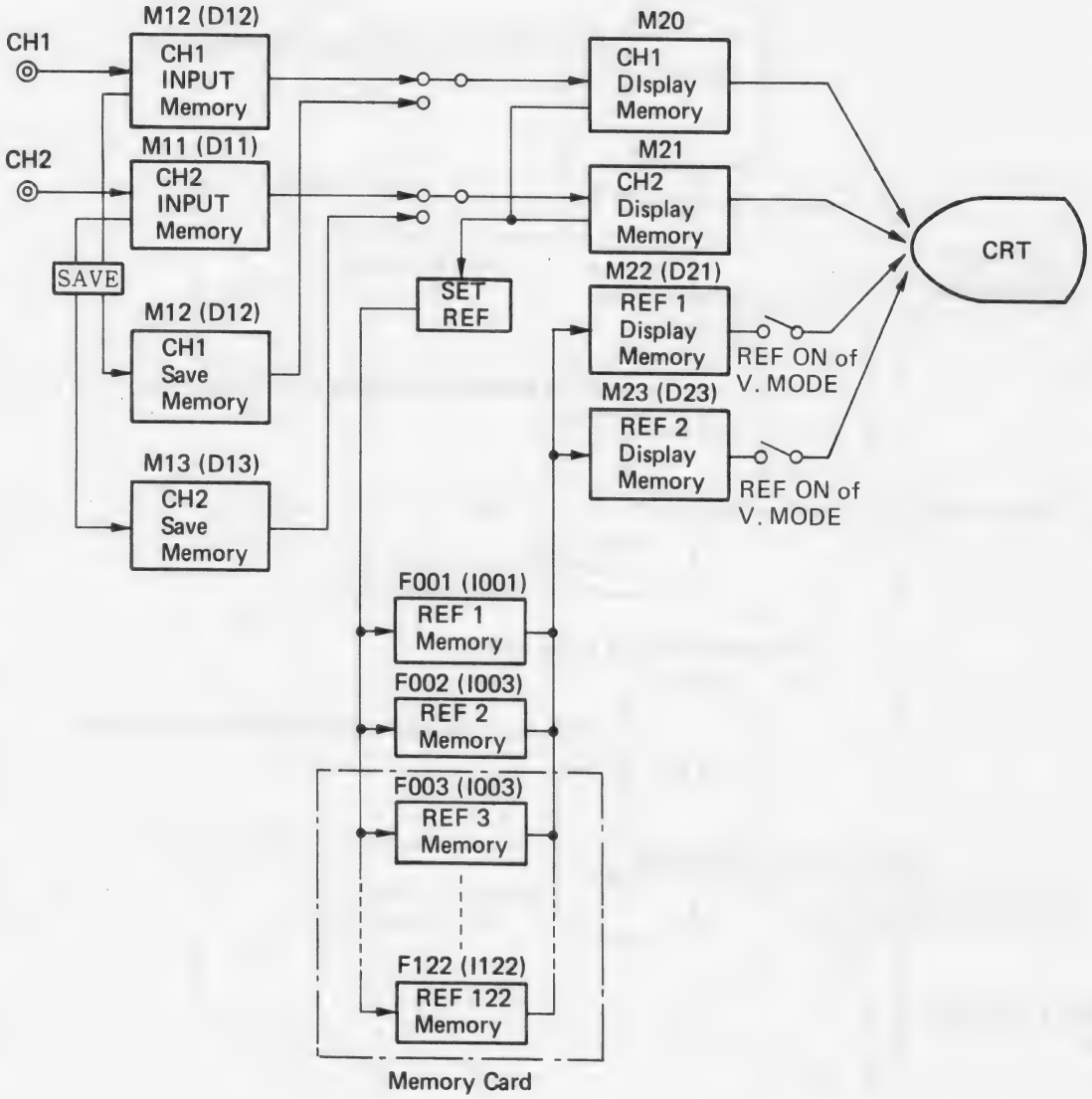
By this addition, each parameter between F001 ~ F122 is available for waveform and auxiliary I/O command and I001 ~ I122 is available for waveform collateral information I/O command.



Relationship of memory and file

Figure 5-5-3 shows the relationship of memory and file.

Figure 5-5-3. Memory and File



d. Sending the Auxiliary Information

Of specified auxiliary information, this instrument outputs the following items only. (ASCII code)

Basic Transfer Sequence and Format (Example)

1. No. of data	AA ❩ 7 ❩
2. No. of binary data	AB ❩ 2 ❩
3. Data length	AC ❩ 16384 ❩
4. ΔX	AD ❩ 2.0E–03 ❩
5. Y-FULL SCALE	AE ❩ 1.024E + 02 ❩
6. No. of DELAY WORDs	AF ❩ –16000 ❩
7. ZERO value	AG ❩ –32768 ❩
	↓
❩ : delimiter	Identification code

- No. of data

  7 are fixed. This means that 7 auxiliary data are provided.

- No. of binary data

  2 are fixed. This means that 2 bytes and 1 data are available in transferring the waveform data.

- Data length (waveform data length)

  With the data length of 1 kw : 1024
  16 kw : 16384

- ΔX (resolution per data)

  ΔX is obtained as follows:

  Assume that a sweep time (SEC/DIV) for the waveform displayed on the screen is T_1, and that a sweep time (SEC/DIV) when capturing the waveform is T_0. T_0 is normally equal to T_1. In the modes other than the ROLL mode, however, it is 5 μs/div when high-speed sweep at 5 μs/div or faster is applied. In the ROLL mode, it is 0.1 ms/div when high-speed sweep at 0.1 ms/div or faster.

  In EQU SAMPLE, T_0 and T_1 are always assumed to be equal.

  From the above, ΔX upon input of the waveform is calculated as follows:

$$\Delta X = \frac{T_0}{100} \quad \text{(except for ROLL mode)}$$

$$\Delta X = \frac{1000 \times T_0}{100} \quad \text{(ROLL mode)}$$

Next, consider the case when the STOP mode is selected after inputting the waveform and panel setting is updated. Assuming that a panel set value after updating (SEC/DIV) is T_2, that the panel set value when maximumly enlarged is T_3 *1, and that the panel set value when minimally reduced is T_4 *1, ΔX in waveform editing is calculated as follows:

$$\Delta X = \frac{T_0}{100} \quad \text{(Enlargement with interpolation turned off)}$$

$$\Delta X = \frac{5 \times T_2}{100} \quad \text{(Enlargement with interpolation turned on: } T_2 \geq T_3\text{)}$$

$$\Delta X = \frac{5 \times T_3}{100} \quad \text{(Enlargement with interpolation turned on: } T_2 < T_3\text{)}$$

$$\Delta X = \frac{T_2}{100} \quad \text{(Reduction: } T_2 \leq T_4\text{)}$$

$$\Delta X = \frac{T_4}{100} \quad \text{(Reduction: } T_2 > T_4\text{)}$$

*1 After entering the waveform, stop it and set the sweep time (SEC/DIV) otherwise. A range just before the one within which "SET UP" is displayed, in turning the range selector to the direction of enlargement and of reduction, is T_3 and T_4 respectively.

[Note] The waveform displayed also multiplies a SEC/DIV value by 1,000 times, if it is the ROLL mode.

- Y-FULL SCALE (physical amount value converted from the maximum value which the waveform data can assume)

$$\text{Y-FULL SCALE} = \frac{256 \times \text{VOLTS/DIV Value at Waveform Data Input Time}}{25}$$

- No. of DELAY WORDs

  DELAY WORD (for length of 1 kw) = DATA POSITION x (–100)
  DELAY WORD (for length of 16 kw) = DATA POSITION x (–100) x 16

- ZERO value

  ZERO value = GND level value (–32768 ~ 32512)

e. Reading out the Cursor Measured Value

A type of cursor measurement currently under way and measured values are output in terms of ASCII code with units.

Output data are as follows:

- First data : The number of data to be sent in subsequently (number of data since the 2nd one inclusive) is output as follows according to the selected cursor function.
- ΔVOLTAGE : CH1 voltage value, CH2 Voltage value
- ΔTIME : Time value, frequency
- VOLTAGE RATIO : Voltage ratio (%), voltage ratio (dB)
- PHASE : Phase (°)
- GND REFERENCE : CH1 voltage value, CH2 voltage value
- PEAK TO PEAK : CH1 P-P value, CH2 P-P value
- MAX & MIN : CH1 MAX value, CH2 MIN value, CH2 MAX value, CH2 MIN value

(Example) for ΔTIME

2) 1.00E−03) 1.00E + 03)

) : delimiter

[Note 1] Data distinguished CH1 and CH2 are output by V-MODE.
CH2V is output in the X-Y mode of ΔVOLTAGE, and CH1 V is output in the X-Y mode of ΔTIME.

[Note 2] When an output result is ∞, "INFINITY" is output.
The following marks may be added:
VARIABLE mark : "<" or ">"
Saturation mark : "<=" or ">="

[Note 3] When cursor measurement is not being performed, 0) is output.

f. Outputting the Status Sense

Current status sense, such as waveform writing under way or writing end, is output in terms of ASCII code.

Output values have the following meanings:

- RUN status
  - 0 : Non-RUN status
  - 1 : RUN status
- GO/NO GO judgment
  - 0 : GO (non-operating)
  - 1 : NO GO
- Waveform input status
  - 0 : Waveform input end
  - 1 : Waveform input under way

(Example) When waveform writing ends while GO/NO GO is operating: (judged as NO GO)

0) 1) 0)

) : delimiter

5-5-4 Status Output

This function informs the external controller of internal operating condition of an instrument, such as error generation, completion of operation, etc. using an SRQ signal and a status byte.

a. SRQ Generation Factors

SRQ generation factors are mainly classified into two cases; when an error takes place and when operation normally terminates.

When an error takes place:

- When an undefined command is received
- GP-IB command parameter error
- When the GP-IB command cannot be executed
- Excessive word length of the GP-IB command

When operation normally terminates:

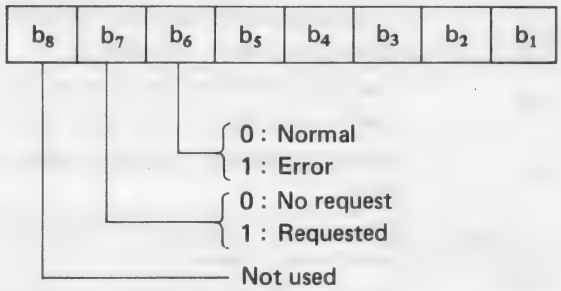
- Completion of storage waveform fetching (completion of AVERAGE and PEAK CH HOLD)
- GO/NO GO judgment result
- Output termination

b. Status Byte

The contents of the SRQ generation factors mentioned in "a. SRQ Generation Factors" can be known by making the external controller read out the status byte with a serial poll sequence.

The following describes the status byte:

- Status byte



Decimal display	b_8	b_7	b_6	b_5	b_4	b_3	b_2	b_1	Description
97	0	1	1	0	0	0	0	1	Excessive word length of the GP-IB command
100	0	1	1	0	0	1	0	0	GP-IB command not executable Example) Sending an operation command during the execution of X-Y operation in the ROLL mode
104	0	1	1	0	1	0	0	0	GP-IB command parameter error
112	0	1	1	1	0	0	0	0	Underfined command received
72	0	1	0	0	1	0	0	0	Waveform fetching completed AVERAGE/ PEAK CH HOLD completed
68	0	1	0	0	0	1	0	0	Output end
66	0	1	0	0	0	0	1	0	GO/NO GO: NO GO
65	0	1	0	0	0	0	0	1	GO/NO GO: GO

c. Clearing the SRQ Signal and Status Byte

- When the serial poll sequence is conducted
- When DCL or SDC is received

5-5-5 Control Message Responses

The following describes control message responses:

Message	Description of Response from the Instrument
IFC	Initializes the interface and makes the Listener and Talker functions idle.
REN	Remote operation is enabled when MLA is also sent.
ATN	Receives the data on the bus as an interface messages and responds to it.
EOI	Used as a delimiter for data transfer record.
DCL, SDC	Unitializes the instrument, interrupts operation and clears SRQ.
SPE, SPD	Performs serial poll operation and sends the status byte.
UNL	Clears the LISTENER mode and interrupts data transfer. Operation can be resumed if the LISTENER mode is specified again.
UNT	Clears the TALKER mode and interrupts data transfer. Operation can be resumed if the TALKER mode is specified again.
MLA	If a current mode is TALKER, it is cleared and switched to the LISTENER mode. Data transfer is forcibly terminated if it is under way.
MTA	If a current mode is LISTENER, it is cleared and switched to the TALKER mode. Data receiving is forcibly terminated if it is under way.
DAV, NRFD NDAC	Data is transferred by 3-wire handshaking.
GTL	The same operation is done as when the LOCAL key on the panel is pressed. Unlocks the panel key and the system is under local control.
LLO	No response

[Note 1] LOCAL mode

When a GTL message is received or the LOCAL key on the panel is pressed after terminating remote control, the instrument enters the REAL mode and other settings assume those provided by the panel. (same as when the power is turned on).

[Note 2] Device Clear

After receiving Device Clear (DCL, SDC), the instrument stops handshaking and performs processing for Device Clear (same as processing provided by the STOP key). Handshaking is cleared after terminating Device Clear processing.

5-6 BUS LINE CONFIGURATION

a. Data Bus (DIO 1 to 8)

8 bidirectional bus lines for transferring multiline messages in a bit parallel and byte serial manner.

b. Handshake Bus (DAV, NRFD, NDAC)

Provides 3-wire handshaking in order to securely transfer multiline messages on the data bus.

- DAV (Data Valid)
  Indicates that the data on the bus is valid.
- NRFD (Not Ready For Data)
  Indicates whether the system is ready for receiving data.
- NDA (Not Data Accepted)
  Indicates whether data receiving is completed.

c. Management Bus (ATN, IFC, REN, SRQ, EOI)

- ATN (Attention)
  This is a signal output by a relevant controller.
  The state that ATN is True (Low level on the bus line because GP-IB is of negative logic) is called the COMMAND mode. When ATN is False (High on the bus line), it is called the DATA mode.
  In the COMMAND mode, the controller transfers a message to all devices on the buses. All messages sent by the controller in the COMMAND mode are provided by standards.
  In the DATA mode, data is transferred to either Talker or Listener.
- IFC (Interface Clear)
  This signal is output by the system controller and used for resetting the interface system.
  When the IFC signal is received, the Talker and Listener functions of the instrument are made idle.
  However, it does not affect the contents of a service request and the status byte.
- REN (Remote Enable)
  This signal is output by the system controller and used for switching remote control/local control of the device. The device specified as Listener with REN being True status assumes remote control.
  If REN is set to False, all devices on the buses will be put in a local control state.
- SRQ (Service Request)
  This is output when the device on the bus requests the controller for a service (one of measurement end, search error occurrence and program error).
- EOI (End Or Identify)
  In the DATA mode, this is used as an END message. The Talker outputs it to indicate the last byte when transmitting data of multiple bytes.
  In the COMMAND mode, it is output from a relevant controller as an IDENTIFY message.

Table 5-6 Bus Lines and Connector Pins

Pin No.	Bus Line	Purpose of Use
1	DIO 1	(LSB)
2	DIO 2	Data bus
3	DIO 3	
4	DIO 4	
5	EOI	Management bus
6	DAV	Handshake bus
7	NRFD	
8	NDAC	
9	IFC	Management bus
10	SRQ	
11	ATN	
12	GND	Grounding
13	DIO 5	Data bus
14	DIO 6	
15	DIO 7	
16	DIO 8	
17	REN	Management bus
18	GND	Grounding
⟨	⟨	
24	GND	

Figure 5-6-1. Interface Functions and Bus Lines

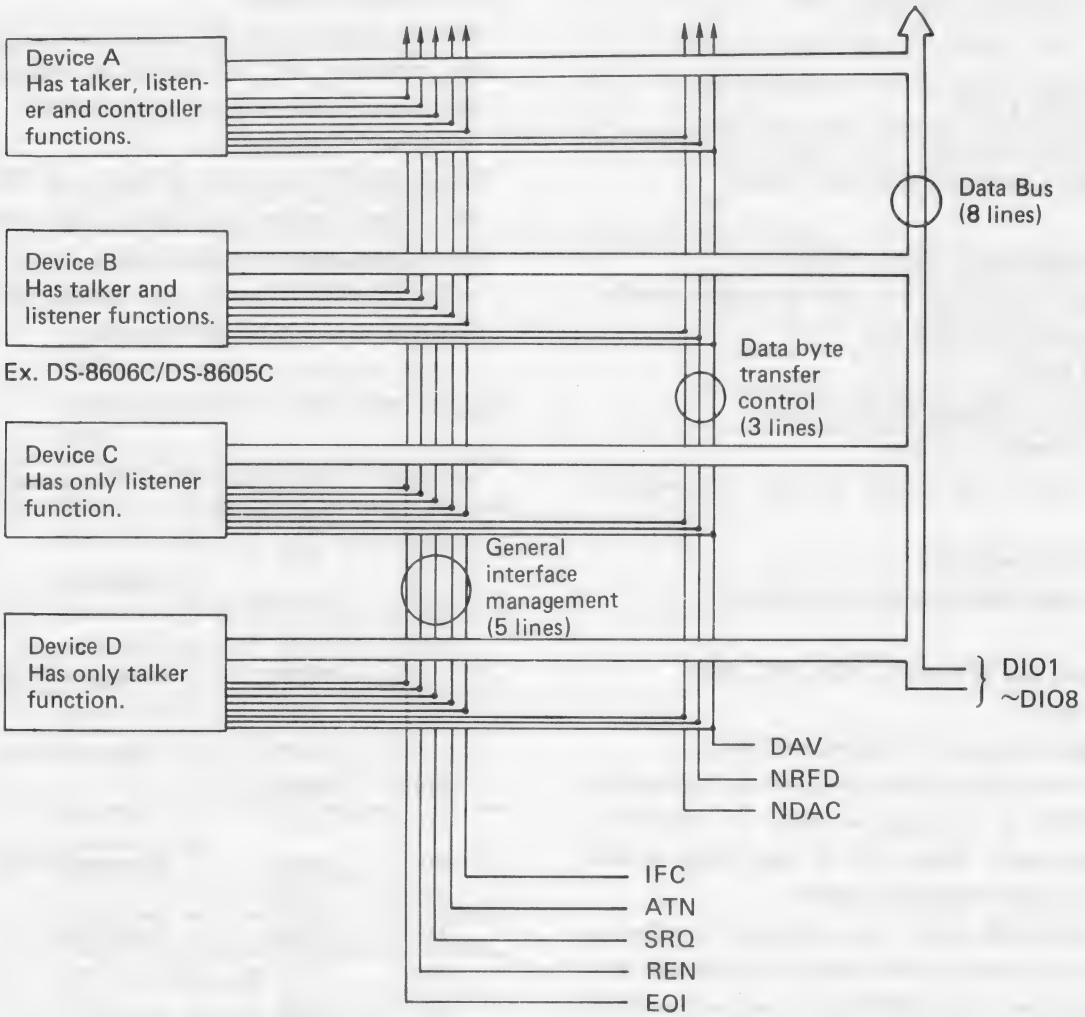
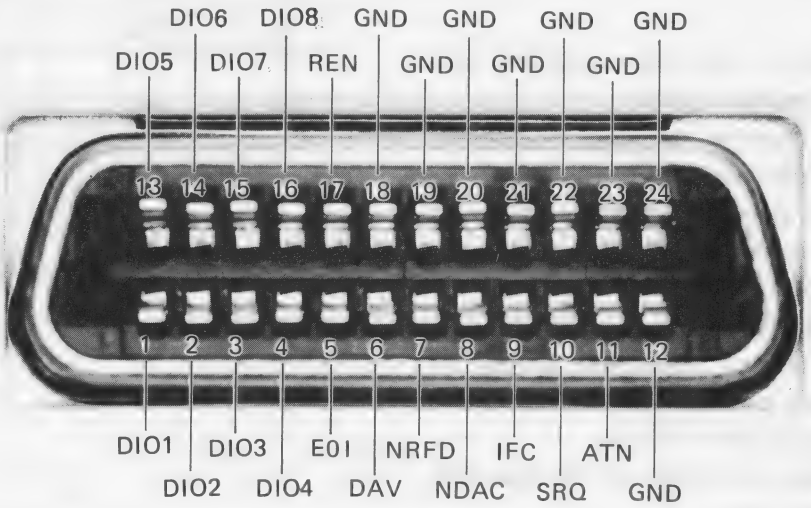


Figure 5-6-2. Bus Lines and Connector Pins



Section 6 Specific Equipment Commands

6-1 GP-IB COMMANDS

GP-IB commands are remote operation control commands to the instrument and sent from the external controller via GP-IB.

The GP-IB commands are classified into the following categories:

- Remote operation commands
- Data transfer commands

As a common matter, however, no multistatement is allowed.

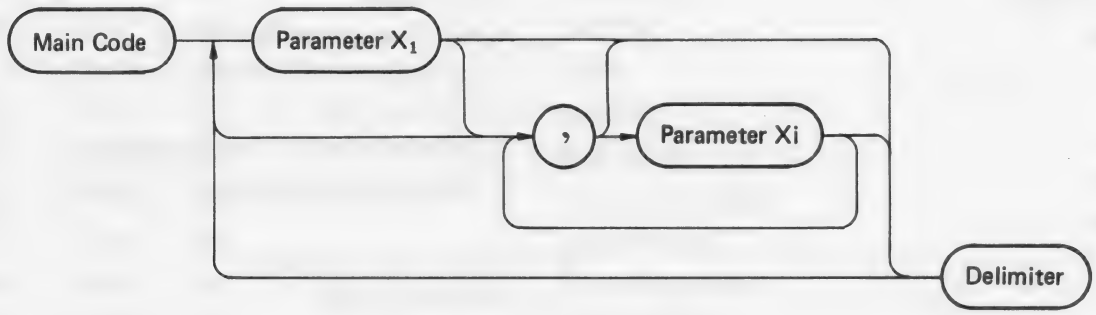
Format

The following describes the code and format for the GP-IB commands.

(1) Input code

ISO 7-bit code

(2) Format



Example. ATD 13

Main code: Code which indicates a control item.
Consists of a combination of 2 or 3 alphanumerals.

Parameter: Indicates details of a function specified by the main code. Sets a numerical value/character string. Space between the main code and parameter.

" , " : Parameter marking-off symbol used when multiple parameters are used.

Delimiter : Indicates an end of one statement.

6-2 COMMAND TYPES

(1) Measurement Parameters

a VERT MODE
b HORIZ DISPLAY
c A SEC/DIV
d B SEC/DIV
e SWEEP MODE
f SINGLE RESET
g A TRIGGER SOURCE
h B TRIGGER SOURCE
i TRIGGER COUPLING
j TRIGGER SLOPE

(2) Operation Modes

a REAL/STORAGE/AVERAGE/PEAK CH HOLD/ROLL
b DATA LENGTH
c EQU-SAMPLING
d INTERPOLATION
e TIME BASE
f OUTPUT
g SAVE
h DISPLAY
i RUN/STOP
j STORE REF

(3) CURSORS & DELAY

a MEASUREMENT BY CURSORS (GO/NO GO included)
b DELAY TIME
c DATA POSITION
d DISP SCROLL
e CURSOR
f SET (GND level setting)

(4) Others

a SRQ (SRQ mask control)
b DMA (DMA selection)

(5) Data Transfer Commands

a Waveform data input
b Waveform data output
c SETUP input
d SETUP output
e Auxiliary information output
f Cursor measured value output
g Status sense output
h Collateral information input on waveform
i Collateral information output on waveform

(6) Memory Card Commands

a AUTO ADVANCE
b FORMAT
c STORE
d RECALL

Table 6-2 Remote Operation Commands List

Item No.	Format	Description
1	MOD ␣ [X1, X2]	VERT MODE
2	HDS ␣ [X]	HORIZ DISPLAY
3	ATD ␣ [X]	A SEC/DIV
4	BTD ␣ [X]	B SEC/DIV
5	OPM ␣ [X]	SWEEP MODE
6	RST	SINGLE RESET
7	TAS ␣ [X]	A TRIGGER SOURCE
8	TBS ␣ [X]	B TRIGGER SOURCE
9	TAC ␣ [X]	TRIGGER COUPLING
10	ATP ␣ [X]	TRIGGER SLOPE
11	MES ␣ [X1, X2, X3]	REAL/STOREGE (NORMAL, AVERAGE, PEAK CH HOLD, ROLL)
12	DTL ␣ [X]	DATA LENGTH
13	EQS ␣ [X]	EQU-SAMPLING ON/OFF
14	IPL ␣ [X]	INTERPOLATION
15	TMB ␣ [X]	TIME BASE
16	OTP ␣ [X1, X2]	OUTPUT
17	SAV ␣ [X]	SAVE
18	DSP ␣ [X1, X2]	DISPLAY
19	RUN ␣ [X]	RUN/STOP
20	CUR ␣ [X1, X2, X3, X4, X5]	Cursor measurement
21	DTM ␣ [X]	DELAY TIME
22	DTP ␣ [X]	DATA POSITION
23	DAD ␣ [X]	DISP SCROLL
24	ZRO	GND setting
25	SRQ ␣ [X1, X2]	SRQ mask
26	DMA ␣ [X1, X2]	DMA selection
27	JX ␣ [X1, X2, X3, X4]	Send command
28	IX ␣ [X1, X2, X3, X4]	Receive command
29	FRM	FORMAT
30	REF ␣ [X1, X2, X3]	AUTO ADVANCE, STORE
31	RCL ␣ [X1, X2]	RECALL

6-3 DETAILS OF COMMANDS

6-3-1 Remote Operation Commands

> **CAUTION**
>
> Unless otherwise specified, all the commands cannot be accepted in RUN status.

(1) VERT MODE

Format

Parameters

X1	VERT MODE
1	CH1
2	CH2
3	ADD*1
4	DUAL
5	TRI*1
6	X-Y

*1 Results in a status error in the STORAGE mode.

X2	ALT (REF OFF)/CHOP (REF ON)
0	ALT (REF OFF)
1	CHOP (REF ON)

(2) HORIZ DISPLAY

Format

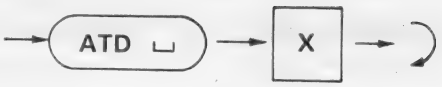
Parameters

X	HORIZ DISPLAY
1	A
2	A INTEN
3	B
4	ALT*1

*1 Status error occurs in the STORAGE mode.

(3) A SEC/DIV

Format



Parameters

X	A SEC/DIV	
	Non-ROLL Mode	ROLL Mode
1	0.5 sec	500 sec
2	0.2 sec	200 sec
3	0.1 sec	100 sec
4	50 msec	50 sec
5	20 msec	20 sec
6	10 msec	10 sec
7	5 msec	5 sec
8	2 msec	2 sec
9	1 msec	1 sec
10	0.5 msec	0.5 sec
11	0.2 msec	0.2 sec
12	0.1 msec	0.1 sec
13	50 μsec	0.1 sec
14	20 μsec	0.1 sec
15	10 μsec	0.1 sec
16	5 μsec	0.1 sec
17	2 μsec	0.1 sec
18	1 μsec	0.1 sec
19	0.5 μsec	0.1 sec
20	0.2 μsec	0.1 sec
21	0.1 μsec	0.1 sec
22	50 n sec	0.1 sec

(*1 applies to Non-ROLL Mode, X = 1 to 12)

*1 Cannot be set in the EQU-SAMPLING mode.

(4) B SEC/DIV

Format

Parameters

X	B SEC/DIV	
	Non-ROLL Mode	ROLL Mode
4	50 msec *1	50 sec
5	20 msec	20 sec
6	10 msec	10 sec
7	5 msec	5 sec
8	2 msec	2 sec
9	1 msec	1 sec
10	0.5 msec	0.5 sec
11	0.2 msec	0.2 sec
12	0.1 msec	0.1 sec
13	50 μsec	0.1 sec
14	20 μsec	0.1 sec
15	10 μsec	0.1 sec
16	5 μsec	0.1 sec
17	2 μsec	0.1 sec
18	1 μsec	0.1 sec
19	0.5 μsec	0.1 sec
20	0.2 μsec	0.1 sec
21	0.1 μsec	0.1 sec
22	50 nsec	0.1 sec

*1 Cannot be set in the EQU-SAMPLING mode

(5) SWEEP MODE

Format

Parameters

X	SWEEP MODE
1	AUTO
2	NORM
3	SINGLE

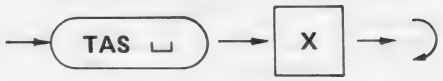
(6) SINGLE RESET

Format

[Note] This command is acceptable even in RUN status.

(7) A TRIGGER SOURCE

Format



Parameters

X	A TRIGGER SOURCE
1	CH1
2	CH2
3	CH3
4	LINE

(8) B TRIGGER SOURCE

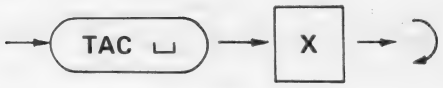
Format

Parameters

X	B TRIGGER SOURCE
0	RUNS AFTER DELAY
1	TRIG'D

(9) TRIGGER COUPLING

Format



Parameters

X	TRIGGER COUPLING
1	AC
2	HF REJ
3	DC
4	TV

(10) TRIGGER SLOPE

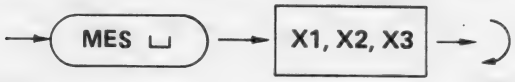
Format

Parameters

X	TRIGGER SLOPE
0	+
1	–

(11) REAL/STORAGE (NORMAL, AVERAGE, PEAK CH HOLD, ROLL)

Format



Parameters

X1	MODE
0	REAL (Initial status)
1	NORMAL (STORAGE)
2	AVERAGE (STORAGE)
3	PEAK CH HOLD (STORAGE)
4	ROLL (STORAGE)

X2	COUNT (Specified Times)
1	2 times
2	4 times
3	8 times
4	16 times
5	32 times
6	64 times
7	128 times
8	256 times
–1	∞*1

*1 Setting disabled in AVERAGE.

X2 or X3	REPEAT ON/OFF*1
0	OFF
1	ON (0 SEC)
2	ON (1 SEC)
3	ON (2 SEC)

*1 The following describes how to specify X2 and X3:

X1	X2	X3
REAL	–	–
NORMAL	REPEAT	–
AVERAGE	COUNT (1 to 8)	REPEAT
PEAK CH HOLD (except ∞)	COUNT (1 to 8)	REPEAT
PEAK CH HOLD (∞)	COUNT (–1)	–
ROLL	–	–

[Note] "–" denotes impossible to set.

(12) DATA LENGTH

Format

Parameters

X	DATA LENGTH
0	1 k word
1	16 k words

(13) EQU-SAMPLING

Format

Parameters

X	EQU-SAMPLING ON/OFF
0	OFF (Initial status)
1	ON

(14) INTERPOLATION

Format

Parameters

X	INTERPOLATION
0	OFF (Initial status)
1	LINEAR
2	SINE

(15) TIME BASE

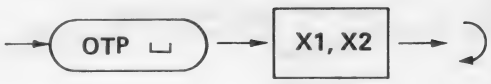
Format

Parameters

X	TIME BASE
0	INT
1	EXT

(16) OUTPUT

Format



Parameters

X1	Device Type	X2	Output Type
0	OFF (Initial status)	–	
1	PEN	0	CAL
		1	SCALE
		2	WAVEFORM
		3	SCALE + WAVEFORM
2	PLOT	–	

[Note] "–" denotes impossible to set.

(17) SAVE

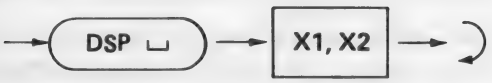
Format

Parameters

X	SAVE CHANNEL
1	SAVE CH1
2	SAVE CH2

(18) DISPLAY

Format



Parameters

X1	CH1 DISP
0	INPUT (Initial status)
1	SAVE

X2	CH2 DISP
0	INPUT (Initial status)
1	SAVE

(19) RUN/STOP

Format

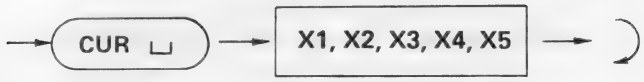
Parameters

X	RUN/STOP
0	STOP
1	RUN

[Note] This command is acceptable even in RUN status.

(20) CURSOR MEASUREMENT

Format



Paramenters

X1	Measurement Item
0	OFF
1	ΔVOLTAGE
2	ΔTIME
3	VOLTAGE RATIO
4	PHASE
5	GND REFERENCE*1
6	PEAK TO PEAK
7	MAX & MIN
8	GO/NO GO*2

*1 When using GND values of auxiliary information or waveform collateral information.
Before taking the waveform, be sure to enter the cursor measurement mode of GND REFERENCE and execute a command of GND setting.

*2 Information of V1 cursor, V2 cursor and REF waveform width can be found in REF memory waveform collateral information and SETUP information.
Therefore, GO/NO GO cursor position and REF waveform width will follow the last command information of the following three commands.

① Integrated setting by SETUP information (IX␣)
② Selection of REF memory number for reference waveform (RCL command)
③ GO/NO GO setting by cursor command (CUR command)

Ex.) When a desired cursor information is not stored in the REF memory waveform collateral information to be a reference waveform in advance. (Refer to GO/NO GO.)
If GO/NO GO is set by "CUR ␣8, X2, X3, X4" first and reference waveform is set by "RCL ␣ m, n," then the cursor position and REF waveform width become that of REFm (or n) waveform collateral information instead of X2, X3, X4.
In this case, select a reference waveform by RCL command first and set GO/NO GO range by CUR command.

X2 to X5: Cursor setting

Measurement Item	Cursor setting			
	X2	X3	X4	X5
OFF	—	—	—	—
ΔVOLTAGE	H1 cursor	H2 cursor	—	—
ΔTIME	V1 cursor	V2 cursor	—	—
VOLTAGE RATIO	H1 cursor	H2 cursor	REF H1 cursor	REF H2 cursor
PHASE	V1 cursor	V2 cursor	REF V1 cursor	REF V2 cursor
GND REFERENCE	V1 cursor	—	—	—
PEAK TO PEAK	V1 cursor	V2 cursor	—	—
MAX & MIN	V1 cursor	V2 cursor	—	—
GO/NO GO	V1 cursor	V2 cursor	REF waveform width	—

[Note] H cursor : –2048 to 2047
V cursor : 0 to 4095
REF Waveform width : 0 to 255
— : Impossible to set

(21) DELAY TIME

Format

Parameters

X : 0 to 4095
Can be set by every 0.0025 div between 0.2 and 10.4375 div.

(22) DATA POSITION

Format

Parameters

X	DATA POSITION
0	0 div (Initial status)
1	1 div
2	2 div
3	3 div
4	4 div
5	5 div
6	6 div
7	7 div
8	8 div
9	9 div
10	10 div

(23) DISP SCROLL

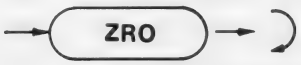
Format

Parameters

X : 0 to 16383
Indicates a display address. When a parameter indicates an odd-number address, it is internally adjusted to an even number.
[Example] 1 → 0
15 → 14

(24) GND SETTING

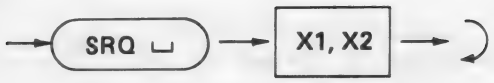
Format



[Note] This is valid only when GND REFERENCE is selected for cursor measurement.

(25) SRQ MASK

Format



Parameters

X1	MASK ON/OFF
0	OFF (Initial status)
1	ON

X2 : Value to be masked (decimal number).
See "5-5-4 Status Output" in Section 5.

[Note] All are allowed (MASK OFF) when the power is turned on.

(26) DMA Selection

Format

Parameters

X	DMA Selection
0	DMA not used (Initial status)
1	DMA used

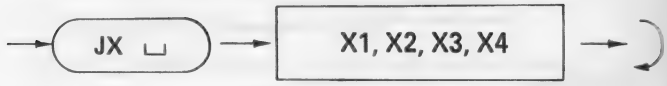
[Note] This command is valid until next change. This is valid only for binary transfer of waveform data transfer and it helps high speed transfer of this unit. However, in GP-IB, data transfer is done while doing handshake with the function of the other device and the speed is determined by the slowest device.

6-3-2 Data Transfer Commands

(27) SEND COMMANDS

a. Waveform Data Read-out Command

Format



Parameters

X1	Transfer Memory File
M10	CH1 INPUT
M11	CH2 INPUT
M12	CH1 SAVE
M13	CH2 SAVE
M20	CH1 DISP
M21	CH2 DISP
M22	REF1 Display
M23	REF2 Display
F001	REF1 (Main memory)
F002	REF2 (Main memory)
F003	REF3 (Memory card)
≀	≀
F122*1	REF122 (Memory card)

*1 The accessory memory card is from F003 to F032.

X2	Data Transfer Type
1	ASCII
3	Binary

X3	Data Length Read from File (number of data)	
1	1k word (1024)	
2	2k words (2048)	Can be set at M10 to M13
4	4k words (4096)	
8	8k words (8192)	
16	16k words (16384)	

X4 : Transfer start block
0 to 15 (by 1 k word)

[Note] "0" when other than M10 to M13.

CAUTION

When the waveform is fetched in the AVERAGE or PEAK CH HOLD mode or with a data length of 1 k word, a data length for M10 or M11 is 1 k word.

b. SETUP Read-out Command

Of panel key information currently set, this command reads out all of it managed by software.

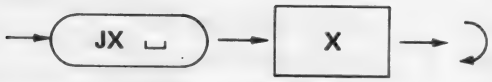
Format

Number of data: 63

[Note] The number of data in the SETUP file differs between writing and reading-out.

c. Waveform Collateral Information Read-out Command

Format



Parameters

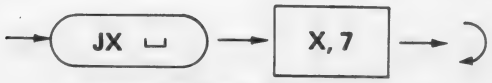
X	Waveform Collateral Information File	
D10	CH1 INPUT	Number of data: 18
D11	CH2 INPUT	
D12	CH1 SAVE	
D13	CH2 SAVE	
D22	REF1 Display	Number of data: 27
D23	REF2 Display	
I001	REF1 (Main memory)	
I002	REF2 (Main memory)	
I003	REF3 (Memory card)	
≀	≀	
I122*1	REF122 (Memory card)	

*1 The accessory memory card is I003 to I032.

A sample program is shown in Section 6-4-3.

d. Auxiliary Information Read-out Command

Format



Number of data: 14 (7 pairs)

Output

Refer to "Sending the Auxiliary Information."

Parameters

X	Input Result Memory File
M10	CH1 INPUT
M11	CH2 INPUT
M12	CH1 SAVE
M13	CH2 SAVE
M20	CH1 DISP
M21	CH2 DISP
M22	REF1 Display
M23	REF2 Display
I001	REF1 (Main memory)
I002	REF2 (Main memory)
I003	REF3 (Memory card)
≀	≀
I122*1	REF122 (Memory card)

*1 The accessory memory card is I003 to I032.

e. Cursor Measured Value Read-out Command

This command sends a value of cursor measurement currently under way. The first data shows the number of data sent subsequently.

Format

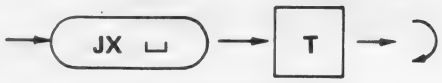
Output

Refer to "Reading out the Cursor Measured Value."

f. Status Sense Output

This command outputs the current RUN mode and a GO/NO GO judgment result.

Format



Number of data: 3

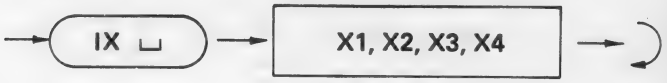
[Note] This is acceptable even in RUN status.

1) D10 ~ D13: The sweeping ranges of waveform collateral information and of the current setting are compared and enlarge or compress the waveform data display transferred to the main unit.
However, when contradictory settings are made, "SETUP" display may appear on the screen.
Ex.) Either channel cannot be compressed enough:
Sweeping range of waveform collateral information
1 ms/div
Current setting range in the main unit
10 ms/div
2) D22, 23 and I001 ~ I122
REF memory readout display on the upper left of the screen changes according to waveform collateral information.

(28) RECEIVE COMMANDS

a. Waveform Data Write Command

Format



Parameters

X1	Transfer Memory File
M10	CH1 INPUT
M11	CH2 INPUT
M12	CH1 SAVE
M13	CH2 SAVE
M22	REF1 Display
M23	REF2 Display
F001	REF1 (Main memory)
F002	REF2 (Main memory)
F003	REF3 (Memory card)
≀	≀
F122*1	REF122 (Memory card)

*1 The accessory memory card is from F003 to F032.

X2	Data Transfer Type
1	ASCII
3	BINARY (2 byte 1 word)

X3	Data Size Written into File	
1	1 k word (1024)	
2	2 k words (2048)	Can be set at M12, M13
4	4 k words (4096)	
8	8 k words (8192)	
16	16 k words (16384)	

X4 : Transfer start block
0 to 15 (by 1 k word)

[Note] Selectable for M12 and M13 when the data length is 16 kW. Otherwise 0.

CAUTION

When the data length is 16 k words, M10 or M11 cannot be set. Also, in the RUN mode, writing is disabled.

b. SETUP Writing Command

This command rewrites all panel key information managed by software. When information impossible to set is received, no relevant panel key processing is done.

Format

Number of data: 53

Setting Order of SETUP Receive Data

When SETUP data is received from GP-IB, each function is executed in the following order:

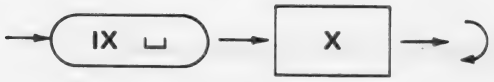
1. V-MODE
2. STORAGE MODE
3. REAL/STORAGE
4. TIME BASE
5. DATA LENGTH
6. EQU-SAMPLE
7. INTERPOLATION
8. DISPLAY
9. OUTPUT
10. CURSOR MEASUREMENT
    - ΔVOLTAGE
    - ΔTIME
    - VOLTAGE RATIO
    - PHASE
    - GND REF
    - PEAK TO PEAK
    - MAX AND MIN
    - GO/NO GO
    - DELAY TIME
    - DATA POSITION
    - DISP SCROLL

    Sequentially viewing from the top, one turned on first is executed.

    When all are turned off, execution ends.
11. DELAY TIME (hard setting only)
12. TRIGGER SOURCE
    TRIGGER COUPLING
    TRIGGER SLOPE
    SWEEP MODE
    HORIZ AFTER/TRIG'D
    A SEC/DIV
    B SEC/DIV

c. Waveform Collateral Information Writing Command

Format



Parameters

X	Waveform Collateral Information File	
D10	CH1 INPUT	Number of data: 18
D11	CH2 INPUT	
D12	CH1 SAVE	
D13	CH2 SAVE	
D22	REF1 Display	Number of data: 27
D23	REF2 Display	
I001	REF1 (Main memory)	
I002	REF2 (Main memory)	
I003	REF3 (Memory card)	
≀	≀	
I122*1	REF122 (Memory card)	

*1 The accessory memory card is I003 to I032.

[Note] The number of data of information incidental to waveforms depends on the files.

[Note 2] Transfer waveform collateral information to this unit before the data of corresponding waveform.

Ex.) IX ␣ I003
→ Waveform Collateral Information Data (27 data)
→ IX ␣ F003, 3, L0
→ Waveform Data (1024 data)

Reference

Information of sweeping range at input of waveform is included in the waveform collateral information.

When waveform collateral information is transferred to the main unit together with the waveform data, the main unit works in the following ways according to the contents of information.

6-3-3 Memory Card Commands

(29) FORMAT

This command formats a memory card.

Format

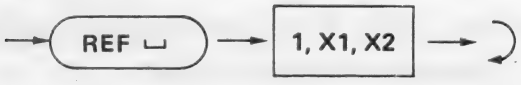
(30) STORE

a. AUTO ADVANCE OFF

Format

b. AUTO ADVANCE ON

Format



Parameter

X1 (File number for start) : 3 ~ 122
X2 (File number for stop) : 3 ~ 122

[Note] If RUN status is set after AUTO ADVANCE is ON, AUTO ADVANCE will start.

c. STORE REF

This command stores the waveform in REF memory.

Format

Parameter

X1	CH1/CH2
1	CH1
2	CH2

X2 (File number of store) : 1 to 122

(31) RECALL

Format

X1 (File number to recall to REF display memory): 1 ~ 122

X2	REF1/REF2 Display Memory Designation
1	REF 1
2	REF 2

[Note] The actual waveform display on the screen is according to VERT MODE (MOD command).

6-4 SAMPLE PROGRAM

6-4-1 PC-9801 (I)

Waveforms taken in by the instrument are transferred to the controller and displayed.

```
10 '********** DS-8606/DS8605 GP-IB TEST PROGRAM ***********
20 '
30 ISET IFC
40 ISET REN
50 DM=30                    'DS-8606 : GP-IB ADDR=30
60 S=0
70 CMD DELIM=0
80 SRQ OFF
90 ON SRQ GOSUB *INTR
100 SRQ ON
110 WBYTE &H14;             'DEVICE CLEAR
120 CLS 3
130 DIM BUFFER1(1023)
140 DIM BUFFER2(1023)
150 '********** SET SETUP ***********"
160 PRINT@ DM;"RUN 0"       'RUN/STOP          STOP
170 PRINT@ DM;"MOD 4,0"     'V MODE            DUAL,REF OFF
180 PRINT@ DM;"HDS 1"       'H DISPLAY         A
190 PRINT@ DM;"ATD 14"      'A TIME/DIV        20USEC/DIV
200 PRINT@ DM;"TAS 1"       'A TRIG.SOURCE     CH1
210 PRINT@ DM;"TAC 1"       'TRIG. COUPLING    AC
220 PRINT@ DM;"ATP 0"       'TRIG. SLOPE       +
230 PRINT@ DM;"MES 1,1"     'STORAGE MODE      NORMAL,COUNT 2
240 PRINT@ DM;"DTL 0"       'DATA LENGTH       1K WORD
250 PRINT@ DM;"IPL 0"       'INTERPOLATION     OFF
260 PRINT@ DM;"TMB 0"       'TIME BASE         INT
270 PRINT@ DM;"DSP 0,0"     'DISPLAY CH1,2     INPUT
280 PRINT@ DM;"CUR 0"       'CURSOR            OFF
290 PRINT@ DM;"DTP 0"       'DATA POSITION     0DIV
300 PRINT@ DM;"DMA 1"       'DMA               OFF
310 PRINT@ DM;"OPM 3"       'SWEEP MODE        SINGLE
320 PRINT@ DM;"RUN 1"       'RUN/STOP          RUN
330 PRINT@ DM;"RST"         'SINGLE RESET
340 '******************** WAIT FOR SRQ= 72 (WAVE IN) *******
350 '
360 IF S<> 72 THEN GOTO 360
370 PRINT@ DM;"RUN 0"
380 '********** CH1 WAVE DATA RCV **********
390 '
400 PRINT@ DM;"JX M10,3,1,0"
410 WBYTE &H3F,64+DM,32+(IEEE(1) MOD 32);      ' UNL,MTA,MLA
420 FOR I=0 TO 1023
430   RBYTE ;BUFFER1(I),L0
440 NEXT I
```

Comments

Line number	Contents
10 to 110	Initial setting
120 to 330	The instrument setting
340 to 370	SRQ is transmitted to the controller on completion of Data writing. Receiving SRQ, the controller performs the serial polling, and when the number is found to be 72 (finishing taking in waveforms), it stops taking in waveforms.
380 to 440	Transferred in binary system to the array on which the data, 1 kword, entered into CH1 has been declared.

```
450 '************ CH2 WAVE DATA RCV *************
460 '
470 PRINT@ DM;"JX M11,3,1,0"
480 WBYTE &H3F,64+DM,32+(IEEE(1) MOD 32);       'UNL,MTA,MLA=30
490 FOR I=0 TO 1023
500   RBYTE ;BUFFER2(I),LO
510 NEXT I
520 '
530 '********** DISPLAY CH1 & CH2 WAVE DATA *************
540 CLS 3
550 SCREEN 2,0
560 WINDOW (  0,-128)-(1024,128)
570 VIEW (50,10)-(400,200)
580 '
590 FOR I= 0 TO 1023
600   YY=BUFFER1(I)
610   IF YY>127 THEN  YY=YY-256
620   PSET (I,-YY)
630 NEXT I
640 FOR I=0 TO 1023
650   YY=BUFFER2(I)
660   IF YY>127 THEN YY=YY-256
670   PSET (I,-YY)
680 NEXT I
690 END
700 *INTR
710 POLL DM,S
720 PRINT "******* INTERRUPTED S=";S
730 SRQ ON
740 RETURN
```

Comments

Line number	Contents
450 to 510	Transferred in binary system to the array.
530 to 680	Waveforms are displayed based on the data stored in the arrays.

6-4-2 PC-9801 (II)

Transfers the setpu data of this instrument to the controller to display it.

```
10 '*********************************************
20 '*        DS-8606/C, DS-8605/C                 *
30 '*        DS-6612/C, DS-6411/C                 *
40 '*    SETUP DATA READ SAMPLE PROGRAM           *
50 '*********************************************
60 ISET IFC                                      'INTERFACE CLEAR
70 ISET REN                                      'REMOTE ENABLE
80 DM=30                                         'GP-IB ADDRESS
90 S=0
100 CMD DELIM=0                                   'DELIMITER : CRLF
110 SRQ OFF
120 ON SRQ GOSUB *INTR
130 SRQ ON
140 WBYTE &H14;                                  'DEVICE CLEAR
150 CLS 3
160 DIM SETUP(63)                                'SETUP DATA STORAGE ARRAY
170 COMMAND$="JX S"                              'SETUP DATA RECEIVE COMMAND
180 PRINT@ DM;COMMAND$                           'SEND COMMAND
190 INPUT@ DM;SETUP(1)                           'RECEIVE FIRST SETUP DATA
200 FOR I=2 TO 63
210 INPUT@ ;SETUP(I)                             'RECEIVE ALL DATA
220 NEXT I
230 FOR I=1 TO 21                                'DISPLAY ALL DATA
240 LOCATE 0,I:PRINT "SETUP情報 No.";I;"=";SETUP(I);
250 LOCATE 24,I:PRINT "SETUP情報 NO.";21+I;"=";SETUP(21+I);
260 LOCATE 49,I:PRINT "SETUP情報 No.";42+I;"=";SETUP(42+I);
270 NEXT I
280 STOP
290 END
300 '
310 *INTR                                        'SRQ PROCESSING ROUTINE
320 POLL DM,S
330 PRINT "************* INTERRUPTED S=";S
340 SRQ ON
350 RETURN
```

6-4-3 PC-9801 (III)

Transfers the CH1 waveform collateral information of this instrument to the controller to display it.

```
10 '*******************************************
20 '*        DS-8606/C, DS-8605/C                *
30 '*        DS-6612/C, DS-6411/C                *
40 '*WAVERORM COLLATERAL INFORMATION READ SAMPLE PROGRAM*
50 '*******************************************
60 ISET IFC                                      'INTERFACE CLEAR
70 ISET REN                                      'REMOTE ENABLE
80 DM=30                                         'GP-IB ADDRESS
90 S=0
100 CMD DELIM=0                                   'DELIMITER : CRLF
110 SRQ OFF
120 ON SRQ GOSUB *INTR
130 SRQ ON
140 WBYTE &H14;                                  'DEVICE CLEAR
150 CLS 3
160 DIM SUB(63)              'WAVEFORM COLLATERAL INFORMATION STORAGE ARRAY
170 COMMAND$="JX D10"        'SETUP DATA RECEIVE COMMAND
180 PRINT@ DM;COMMAND$       'SEND COMMAND
190 INPUT@ DM;SUB(1)         'RECEIVE FIRST WAVEFORM COLLATERAL INFORMATION
200 FOR I=2 TO 18
210 INPUT@ ;SUB(I)                               'RECEIVE ALL DATA
220 NEXT I
230 PRINT "* * WAVEFORM COLLATERAL INFORMATION  * * "
240 FOR I=1 TO 9                                 'ALL DATA DISPLAY
250 LOCATE 0,I:PRINT "COLLATERAL INFORMATION No.";I;"=";SUB(I);
260 LOCATE 24,I:PRINT "COLLATERAL INFORMATION No.";9+I;"=";SUB(9+I);
270 NEXT I
280 STOP
290 END
300 '
310 *INTR                                        'SRQ PROCESSING ROUTINE
320 POLL DM,S
330 PRINT "************** INTERRUPTED S=";S
340 SRQ ON
350 RETURN
```

6-4-4 HP-216 (I)

Waveforms taken in by the instrument are transferred to the controller and displayed.

```
10   !*** INITIALIZE ***
20     S=0
30   !
40     INTEGER Buffer1(2047) BUFFER
50     INTEGER Buffer2(2047) BUFFER
60     ASSIGN @Buffer1 TO BUFFER Buffer1(*)
70     ASSIGN @Buffer2 TO BUFFER Buffer2(*)
80     ASSIGN @Device TO 730
90     ABORT 7
100    CLEAR 7
110  !
120    ON INTR 7 GOSUB Srq
130    ENABLE INTR 7;2
140  !
150    GCLEAR
160  !
170  !*** SET SETUP ***
180  !
190    OUTPUT @Device USING "K";"RUN 0"
200    OUTPUT @Device USING "K";"MOD 4,0"
210    OUTPUT @Device USING "K";"HDS 1"
220    OUTPUT @Device USING "K";"ATD 14"
230    OUTPUT @Device USING "K";"TAS 1"
240    OUTPUT @Device USING "K";"TAC 2"
250    OUTPUT @Device USING "K";"ATP 0"
260    OUTPUT @Device USING "K";"MES 1,1"
270    OUTPUT @Device USING "K";"DTL 0"
280    OUTPUT @Device USING "K";"IPL 0"
290    OUTPUT @Device USING "K";"TMB 0"
300    OUTPUT @Device USING "K";"DSP 0,0"
310    OUTPUT @Device USING "K";"CUR 0"
320    OUTPUT @Device USING "K";"DTP 0"
330    OUTPUT @Device USING "K";"DMA 1"
340    OUTPUT @Device USING "K";"OPM 3"
350    OUTPUT @Device USING "K";"RUN 1"
360    OUTPUT @Device USING "K";"RST"
370  !
380    IF S<>72 THEN GOTO 380
390    OUTPUT @Device USING "K";"RUN 0"
400  !
410  !*** CH1 WAVE DATA RCV. ***
420  !
430    OUTPUT @Device USING "K";"JX M10,3,1,0"
440  !
450    TRANSFER @Device TO @Buffer1;COUNT 2048
460  !
470  !*** CH2 WAVE DATA RCV. ***
480  !
490    OUTPUT @Device USING "K";"JX M11,3,1,0"
500  !
510    TRANSFER @Device TO @Buffer2;COUNT 2048
520  !
```

Comments

Line number	Contents
10 to 150	Initial setting
170 to 360	The instrument setting
380 and 390	SRQ is transmitted to the controller on completion of Data writing. Receiving SRQ, the controller performs the serial polling, and when the number is found to be 72 (finishing taking in waveforms), it stops taking in waveforms.
410 to 450	Transferred in binary system to the array on which the data, 1 kword, entered into CH1 has been declared.
470 to 510	Transferred in binary system to the array.

```
530 ! *** GRAPHICS WAVE DATA ***
540 !
550   GCLEAR
560   GRAPHICS ON
570   WINDOW 0,1023,-128,128
580   VIEWPORT 0,400,0,200
590   MOVE 0,0
700 !
720   FOR I=0 TO 1023
730     PLOT I,Buffer1(I)/256
740   NEXT I
750 !
760   PLOT 0,Buffer2(0)/256,-2
770   FOR I=1 TO 1023
780     PLOT I,Buffer2(I)/256
790   NEXT I
800 !
810   LOCAL 7
820   STOP
830 Srq: !
840   S=SPOLL(@Device)
850   DISP "*** INTERRUPTED S=";S
860   ENABLE INTR 7;2
870   RETURN
880   END
```

Comments

Line number	Contents
530 to 820	Waveforms are displayed based on the data stored in the arrays.

6-4-5 HP-216 (Ⅱ)

Waveforms taken in by the instrument is printed out to the plotter through the controller. The instrument and the plotter can be set as follows.

The instrument..... ADDRESS 30 CR LF
Plotter ..... ADDRESS 5

```
10   ! **** INITIALIZE ****
20     S=0
30   !
40     ASSIGN @Dv2 TO 705
50     ASSIGN @Device TO 730
60     ABORT 7
70     CLEAR 7
80   !
90     ON INTR 7 GOSUB Srq
100    ENABLE INTR 7;2
110  !
120  ! **** PLOTTER OUTPUT  SETUP ****
130  !
140  OUTPUT @Device USING "K";"RUN 0"    ! STOP
150  OUTPUT @Device USING "K";"MES 1,1"  ! NORMAL
160  OUTPUT @Device USING "K";"MOD 1,0"  ! CH1
170  OUTPUT @Device USING "K";"HDS 1"    ! A
180  OUTPUT @Device USING "K";"ATD 14"   ! 20USEC/DIV
190  OUTPUT @Device USING "K";"OTP 2"    ! OUTPUT PLOT
200  OUTPUT @Device USING "K";"RUN 1"    ! RUN
210  !
220  ! **** OUTPUT START ****
230  !
240  WAIT 1
250  SEND 7;CMD UNL UNT TALK 30 LISTEN 5
260  SEND 7;DATA
270  IF S=68 THEN GOTO 290
280  GOTO 270
290  !
300  LOCAL 7
310  STOP
320  !
330  !
340  Srq:!
350  S=SPOLL(@Device)
360  DISP "*** INTERRUPTED S=";S
370  RETURN
380  END
```

Comments

Line number	Contents
10 to 100	Initial setting
120 to 200	The instrument setting
220 to 310	Designate the instrument as a talker and the plotter as a listener. After printing out, the plotter receives SRQ, performs the serial polling. When the number is found to be 68 (finishing printing out), it is localized and ends the polling.

MEMO

Section 7 RS-232C Interface

7-1 General

The instrument allows DS-505 (unit for RS-232C) to be attached to it.

When DS-505 is attached, an automatic measuring system can be easily configured by connecting to a personal computer, etc. which has the RS-232C interface.

7-1-1 Interface Functions

This instrument can be remote-controlled through external units and can exchange data with them. And this is in conformity with EIA RS-232C electrically and mechanically.

7-1-2 Construction

This instrument can be connected to an external controller (mini-computer, personal computer, etc.) or a plotter (HP-GL format) via RS-232C.

7-1-3 Specifications of RS-232C

Synchronous/asynchronous:
Asynchronous
Character length:
7 or 8 bits
Parity Enable:
Disabled or Enabled
Parity Sense:
Odd parity or even parity
Stop Bits:
1 or 2 bits
Baud Rate:
600 BPS, 1200 BPS, 2400 BPS, 4800 BPS or 9600 BPS

CAUTION

This instrument is to be used under conditions which are relatively good electrically and physically.

7-2 COMMUNICATION PARAMETERS

7-2-1 General

To perform data transmission correctly using the RS-232C, it is necessary that the communication parameters of the DS-8606C correspond to the transmission parameters of the RS-232C device to be connected.

Setting of transmission parameters including baud rate, character length, stop bit, parity bit, and record delimiter is required.

A typical character frame on the data line is as shown in Fig. 7-2.

a. Character Data Bit

A character data bit is a binary code for which the character to be transmitted. Set to 7 bits or 8 bits.

b. Parity Bit

A parity bit is to detect whether each bit in a character is correctly received and error is detected by making total number of bit "1" in the entire characters sent either even or odd. Set to parity enable and parity sense.

c. Stop Bit

A stop bit indicates the end of each character. Set to 1 bit or 2 bits.

d. Baud rate

Sets the transmission rate (baud rate) of the interface. When the baud rates of equipment connected via the RS-232C are different, normal data transmission is impossible. Specify one of 75, 150, 300, 600, 1200, 2400, 4800 and 9600 (BPS).

e. Start Bit

A start bit announces a receiving equipment that a new character is being sent out.

f. Record delimiter

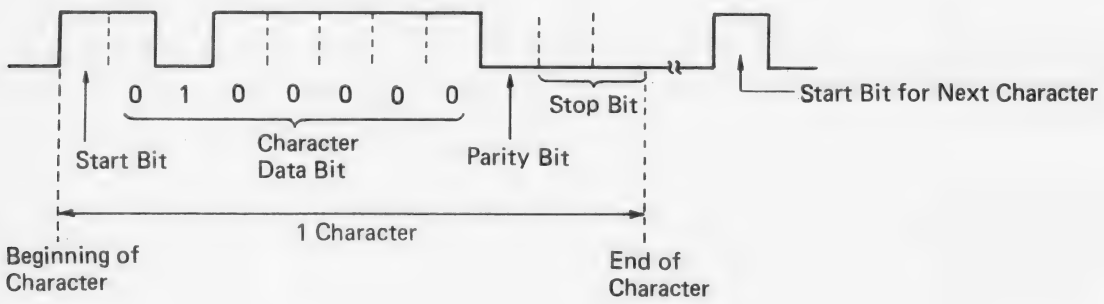
This delimiter is intended for showing the end of data string, data block and data record, that are transmitted between the controller and this instrument.

LF, CR or LF CR is selected.

LF : Line Feed

CR : Carriage Return

Figure 7-2. Character Format



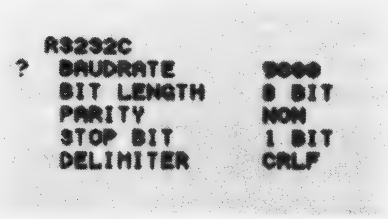
Character length	:	7 bits
Parity bits	:	even parity
Stop bits	:	2 bits

7-2-2 Setting the Communication Parameters

When DS-505 is mounted, every time [STORAGE] is pressed, the screen is changed over as follows:

REAL Screen → STORAGE measurement Screen → STORAGE Character Screen → MEMORY CARD Character Screen and RS-232C Character Screen

Setting the Communication Parameters on the RS-232C character Screen.

RS-232C Character Screen	Operating Method
	• Index keys ([⇧] , [⇩]) Select the item you want to set. Pressing [⇧] moves a mark "?" upward, and [⇩] moves it downward. • Rotary encoder Set the items specified with the mark "?"

Backing up the set item

The information set as above is stored in the nonvolatile RAM. So it is kept valid even when the power supply is put off, and backed up until it is set otherwise.

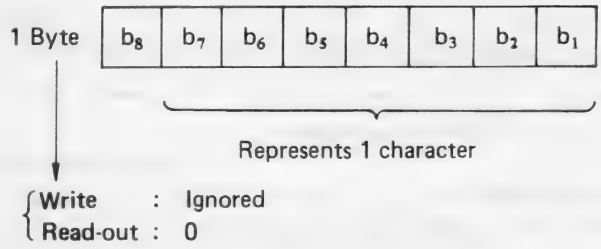
7-3 DATA CODES

The following codes are selectively used in order to represent the contents of data groups, etc. with RS-232C commands or data transfer.

- ASCII code
- Binary code

a. ASCII Code

All of IS07 Bit Code

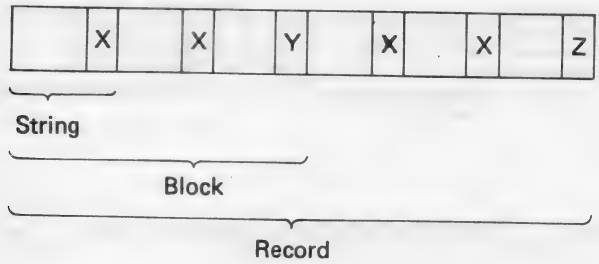


b. Binary Code

Data contents are shown in binary numbers.

7-4 DATA TRANSFER FORMAT

Data transferred on RS-232C consists of components; string, block and record.



X : String delimiter
Y : Block delimiter
Z : Record delimiter

String : Group of a series of data bytes which shows one value

Block : Group of strings which shows the same type

Record : Group of block (strings) to be transferred at one time

For this instrument, however, the block and record are equal to each other. To mark off the record, ASCII transfer format uses CR/LF/CRLF, but this cannot be used in binary transfer format. So mark it off by the number of bytes.

7-4-1 Strings by Transfer Type

Data transfer of this instrument includes waveform data input/output, SETUP input/output, auxiliary information output and cursor measured value output.

The following describes the strings for each transfer type.

Waveform Data Internal Representation

The internal representation of waveform data is treated as a signed 1 byte (2's complement).

A signed 1 byte (2's complement) is a representation which treats the upper most bit as a sign. The correspondence of a signed 1 byte and the screen is shown in Figure 7-4-1.

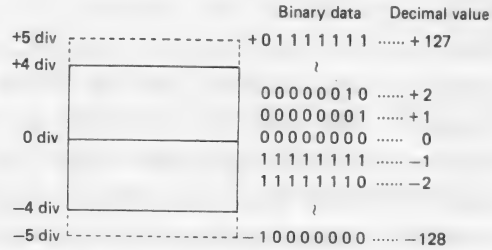
Vertical axis resolution: Approx. 10 div on screen is represented by 8 bits (236 steps); therefore, the resolution is 25 dots/1 div.

Horizontal axis display resolution: Approx. 10 div on screen is represented by 1 kw (1024); therefore, the resolution is 100 dots/1 div.

The value of sweeping range SEC/DIV is divided by 100 and the reciprocal of the resulting value is the sampling rate at that sweeping range. (However, DS-8606C: Max. 20 M samples/S) For 16 kw, the actual sampling rate of input result memory and SAVE memory is different from the one on display.

In that case, the value is ten times larger per 1 kw sampling rate. (However, DS-8606C: Max. 20 M samples/S)

Figure 7-4-1. Correspondence of a Signed 1 byte and the Screen



[Note] The broken lines stand for the area outside the screen.

Table 7-4-1

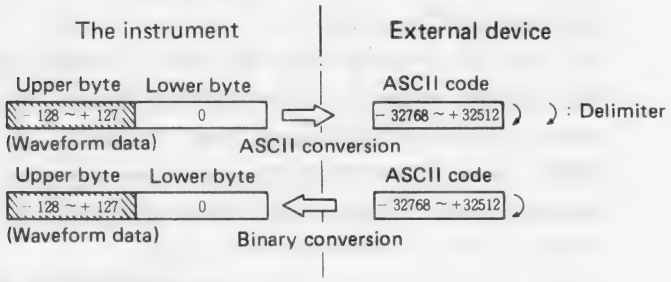
Item \ Format	Data Representation	No. of String Bytes	String Mark-off
Waveform data (ASCII)	ASCII code (with signed integer)	Input: Indefinite Output: Up to 6 bytes	Delimiter
Waveform (binary)	Binary value	2 bytes	2-byte data
SETUP and waveform collateral information	ASCII code (with signed integer)	Input: Indefinite Output: Up to 6 bytes	Delimiter
Auxiliary information	Combination of ASCII code	Up to 10 bytes	Delimiter
Cursor measured value	Combination of ASCII code	Up to 11 bytes	Delimiter
Status sense	ASCII code	1 byte	Delimiter

Waveform Data Format

a. ASCII Code Type

In order to match with binary code type, transfer is made as a decimally converted value of signed 16 bits which has 1 byte of waveform data as the upper bit and 0 (00H) attached to the lower bit. In other words, −32768 ~ +32512, which is simply −128 ~ +127 times 256, is converted to ASCII code and transferred. Each data is divided by a delimeter.

When matching with the internal data in this unit after transferring data to a computer, etc., simply divide each data by 256 to obtain a value of −128 ~ +127.

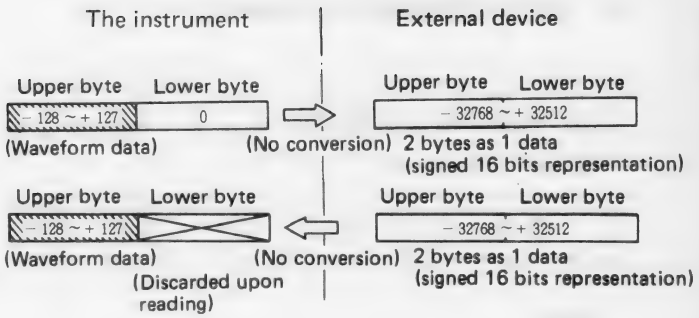


b. Binary Code Type

One byte of the waveform data is set to the upper byte and 0 (00H) is set to the lower byte. Those two bytes are transferred as one data. No delimiter is between the data.

The upper byte is transferred first and the lower byte next.

- When the data is transferred to a computer, etc., it is treated as signed 16 bits 1 data and if each data is divided by 256 after transfer, it can be matched with the internal data of this unit (−128 ~ +127).
- There is another way: the computer discards the lower byte, reading the upper byte only. In this case, however, the computer often fails to treat directly 1 data as signed 8 bits and the read value becomes 0 ~ 256. In order to match the waveform data thus read by a computer with the internal data of this unit, simply subtract 256 (80H) when each data is more than 128. Then, the data can be converted to the value of −128 ~ +127. (Refer to "6-4-1 PC-9801".)



7-4-2 Transfer Format by Transfer Type

The following provides detailed descriptions on transfer formats by transfer type. ") " stands for a delimiter.

a. Input/Output of Waveform Data

- ASCII type transfer

  $d_1 \rangle d_2 \rangle d_3 \rangle$ ..... $\rangle dn \rangle$

  dn : Data (ASCII)

- Binary type transfer

  $d_1\ d_1'\ d_2\ d_2'$ ..... dn dn'

  dn dn' : Data (2 bytes/1w)

  dn' (lower byte) is always "0".

b. Input/Output of SETUP and Waveform Collateral Information

$d_1 \rangle d_2 \rangle d_3 \rangle$ ..... $dn \rangle$

dn : Data (ASCII)

c. Output of Auxiliary Information

$c_1 \rangle d_1 \rangle c_2 \rangle d_2 \rangle$ ..... $c_7 \rangle d_7 \rangle$

c_1 : Identification code
d_1 : Data
} ASCII code

d. Output of Cursor Measured Value

$e \rangle d_1 \rangle d_2 \rangle d_3 \rangle$ ..... $dn \rangle$

e : No. of data
dn : Data
} ASCII code

e. Output of Status Sense

$d_1 \rangle d_2 \rangle d_3$

d_1 : RUN status
d_2 : GO/NO GO judgment
d_3 : Waveform input status
} ASCII code

7-4-3 Various Calculation Methods from Waveform Data

(1) Obtaining the voltage value of the point-to-point data

1. Convert the waveform data of 2 points into the values of −128 through +127. (Refer to 7-4-3 Strings by Transfer Type)
2. A point-to-point voltage value is obtained by the following expression.

$$\text{Voltage value} = \frac{(\text{Waveform data 1} - \text{Waveform data 2}) \times (\text{VOLTS/div})}{25}$$

- Waveform data 1 and waveform data 2:
  Values of −128 through +127 obtained in the step 1
- VOLTS/div:
  VOLTS/div value obtained from the No. 13 parameter for the waveform collateral information corresponding to the waveform data.
- 25:
  Number of dots per 1 div.

(Example)

Obtaining the point-to-point voltage value in the CH1 waveform data

CH1 waveform data 1 : +44
CH2 waveform data 2 : −56
Wavefrom collateral information No. 13
for D10 : +4

Voltage value
= [(+44) − (−56)] x 50 mV ÷ 25 = 200 mV

(2) Obtaining the true voltage value (allowed for DS-8606/C only)

Note: Before measuring a waveform, be sure to take in a GND value, using the GND REFERENCE function.
(Refer to 4-8-6 GND REFERENCE or 6-3 Details of Commands, (21) Cursor Measurement, and (25) GND Setting in the Instruction Manual)

1. Convert the waveform data, whose voltage value you want to obtain, into the value of −128 through +127.
(Refer to 5-4-1 Strings by Transfer Type)
2. Obtain the true voltage value by the following expression.

$$\text{Voltage value} = \frac{(\text{Waveform data} - \text{GND value}) \times (\text{VOLTS/div})}{25}$$

- Waveform data:
  Value of −128 through +127 obtained in the step 1
- GND value:
  (Value of waveform collateral information No.7) −128 for CH1 INPUT, CH2 INPUT, CH1 SAVE, or CH2 SAVE
  (Value of waveform collateral information No.7) −128 for REF1 through REF122
- VOLTS/div:
  VOLTS/div value obtained from the No. 13 parameter for the waveform collateral information corresponding to the waveform data
- 25:
  Number of dots per 1 div

(Example)

Obtaining the voltage value of a certain point in the CH2 waveform data

CH1 waveform data 1: +44
- Waveform collateral information No. 7 for D11: +135
- Waveform collateral information No. 136 for D11: +6

Conversion of the GND value
GND value = (+135) − 128 = +7

Voltage value
= [(+44) − (+7)] x 0.2V ÷ 25 = 0.296 V

(3) Calculating the true time relationship between data

SEC/div corresponding to the *No.11 or No. 12 parameter of the waveform collateral information

$$\frac{\text{Current SEC/div}}{100} \times (\text{Address difference between data})$$

1 div = 100 data

With this expression, you can obtain the true time relationship between data.

Use No. 12 for *CH1 INPUT, CH2 INPUT, CH1 SAVE, and CH2 SAVE.

Use No. 11 for REF1 through REF122.

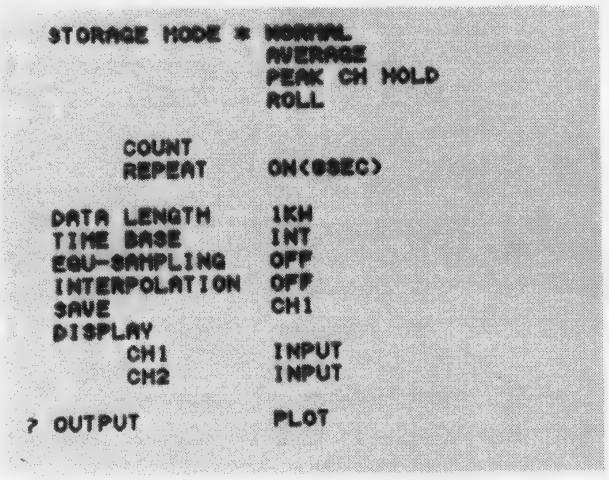
7-5 PLOTTER OUTPUT

This instrument can directly send the data to the plotter (corresponding to HP-GL) through RS-232C.

7-5-1 Setting Method

Procedure

1. Set "?" to OUTPUT on the STORAGE MODE menu screen.
2. Select PLOT.



3. To get this instrument to start sending, press RUN/STOP.

7-5-2 Discontinuing sending

This instrument discontinues sending by pressing RUN/STOP.

Depending on the condition of DR (#6 of the connecter), this instrument can discontinue sending in two ways.

a. Pressing RUN/STOP when DR is true
   After the pen moves up to the center, this instrument can discontinue sending.
b. Pressing RUN/STOP when DR is false.
   The pen won't move, and this instrument can immediately discontinue sending.

7-5-3 DR (#6 of the connecter)

DR is used when there is a signal available to reflect the plotter power ON/OFF. In any other cases, connect the POWER ON signal (#25 of the connecter) with DR, which is always true at the time.

[Note] Even if RUN/STOP is pressed when DR is true, this instrument immediately discontinue sending in the following cases.
   a. The RS-232C connecter is not provided for the plotter.
   b. The plotter is put off.

7-5-4 X_{ON}, X_{OFF}

X_{ON} and X_{OFF} can be controlled not by the plotter, but only by the handshake "CS" of hardware.

7-6 REMOTE OPERATIONAL FUNCTIONS

7-6-1 General

This instrument can be remote-controlled by an external controller. (CPU, mini-computer or personal computer) through RS-232C; and by fixed handshakes of the RS-232C command, etc..

- Panel operation
- Data transfer

7-6-2 X_{ON}/X_{OFF} Control

In transmitting a quantity of data from this instrument to the external controller, it is possible to discontinue or re-start transmitting the data by sending X_{OFF} or X_{ON} from the controller to this instument, except when sending the data to the plotter.

X_{OFF} : 13H (Hexadecimal notation ASCII)
X_{ON} : 11H (Hexadecimal notation ASCII)

7-6-3 Panel Operation

Part of panel operation of this instrument can be done with RS-232C commands from the external controller.

The following shows details of panel operation which can be remotely controlled:

- REAL
- STORAGE
  - STORAGE MODE { NORM / AVERAGE / PEAK CH HOLD / ROLL }
  - DATA LENGTH
  - TIME BASE
  - EQU-SAMPLING
  - INTERPOLATION
  - SAVE
  - DISPLAY
  - OUTPUT
- STORE REF
- RUN/STOP
- CURSORS & DELAY { ΔVOLTAGE / ΔTIME / VOLTAGE RATIO / PHASE / GND REFERENCE / PEAK TO PEAK / MAX & MIN / GO/NO GO / DELAY TIME / DATA POSITION / DISP. SCROLL }
- SET (GND level setting)
- V MODE
- HORIZ DISPLAY
- A SEC/DIV
- B SEC/DIV
- SWEEP MODE
- SINGLE RESET
- A TRIGGER SOURCE
- B TRIGGER SOURCE
- TRIGGER COUPLING
- TRIGGER SLOPE

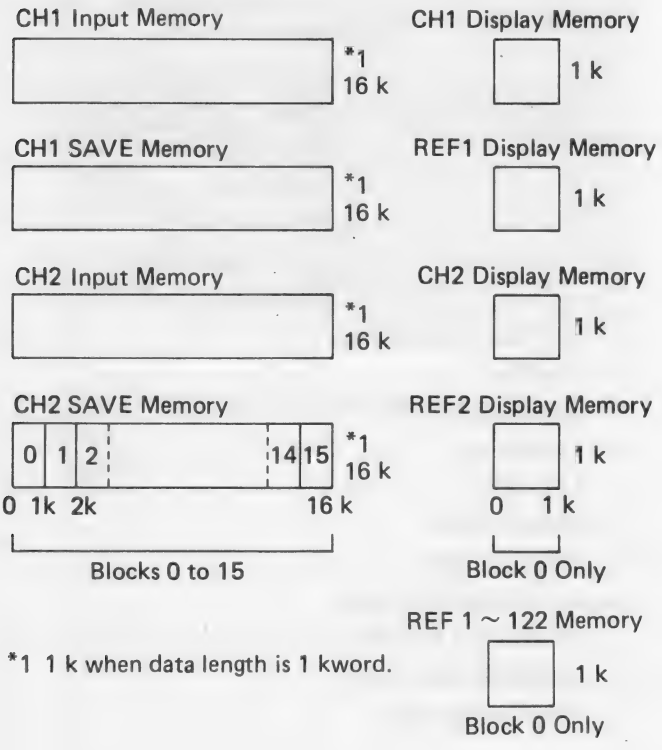
7-6-4 Data Transfer

This instrument provides input/output of waveform data, SETUP data and waveform collateral information, and output of auxiliary information, cursor measured value and status sense.

a. Reading out and Writing the Waveform Data

Reading-out and writing of waveform data are available for each of input memories (CH1, CH2, CH1 SAVE, CH2 SAVE) and each of display memories (CH1, CH2, REF1, REF2, REF1 ~ 122). Either ASCII or binary transfer is selectable. (The data in a memory card is transferrable.)

For the number of transfer data (data length), you can select one of 1 k, 2 k, 4 k, 8 k and 16 k and specify a transfer block by the unit of 1 k.



*1 1 k when data length is 1 kword.

[Note 1] When the data length is 16 kw, no writing can be made into CH1/CH2 input memories. (Allowed into the SAVE memory)

[Note 2] The input result waveform entered in the ROLL mode is stored in the input buffer (data length is always 1 kW).
When it is input in the AVERAGE or PEAK CH HOLD mode, an input result of data length is also 1 kW even if its data length input is 16 kW. In this case, the waveform collateral information indicates a length of 16 kW.

CAUTION

This instrument can indicate waveform data at the length of 8 bits.

Therefore, when transmitting the waveform data under binary notation, normally set the data length at 8 bits.

But, when setting the length at 7 bits, note the following;

When this instrument sends data; MSB (the highest-order bit) is easily deleted.

When this instrument receives data; MSB (the highest-order bit) is automatically set to 0.

b. Reading out and Writing the SETUP Data

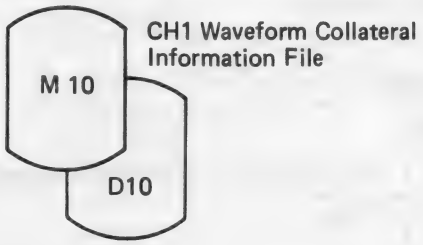
You can collectively perform setting and reading-out as to remotely controllable panel keys.

c. Reading out and Writing the Waveform Collateral Information

To the memory which allows waveform data to be read out and written, its collateral information can be read out and written. (Collateral information related to the CH1 and CH2 display memories are impossible.)

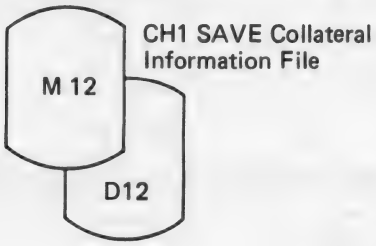
The following describes the files handled by IX and JX commands.

CH1 Input Memory File

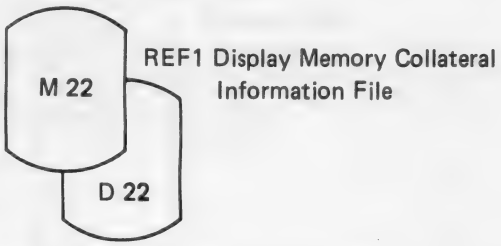


CH1 Display Memory File (only for JX)

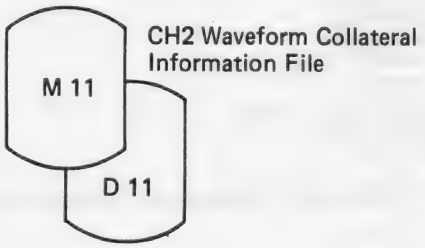
CH1 SAVE Memory File



REF1 Display Memory File

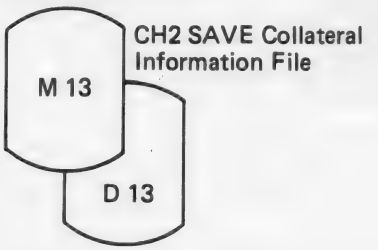


CH2 Input Memory File

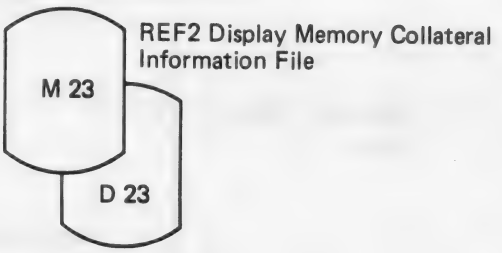


CH2 Display Memory File (only for JX)

CH2 SAVE Memory File



REF2 Display Memory File



SETUP File

Cursor Measurement Result File

Status Sense File

Increase of files by memory card

Files can be increased by adding a memory card.

By this addition, each parameter between F001 ~ F122 is available for waveform and auxiliary I/O command and I001 ~ I122 is available for waveform collateral information I/O command.

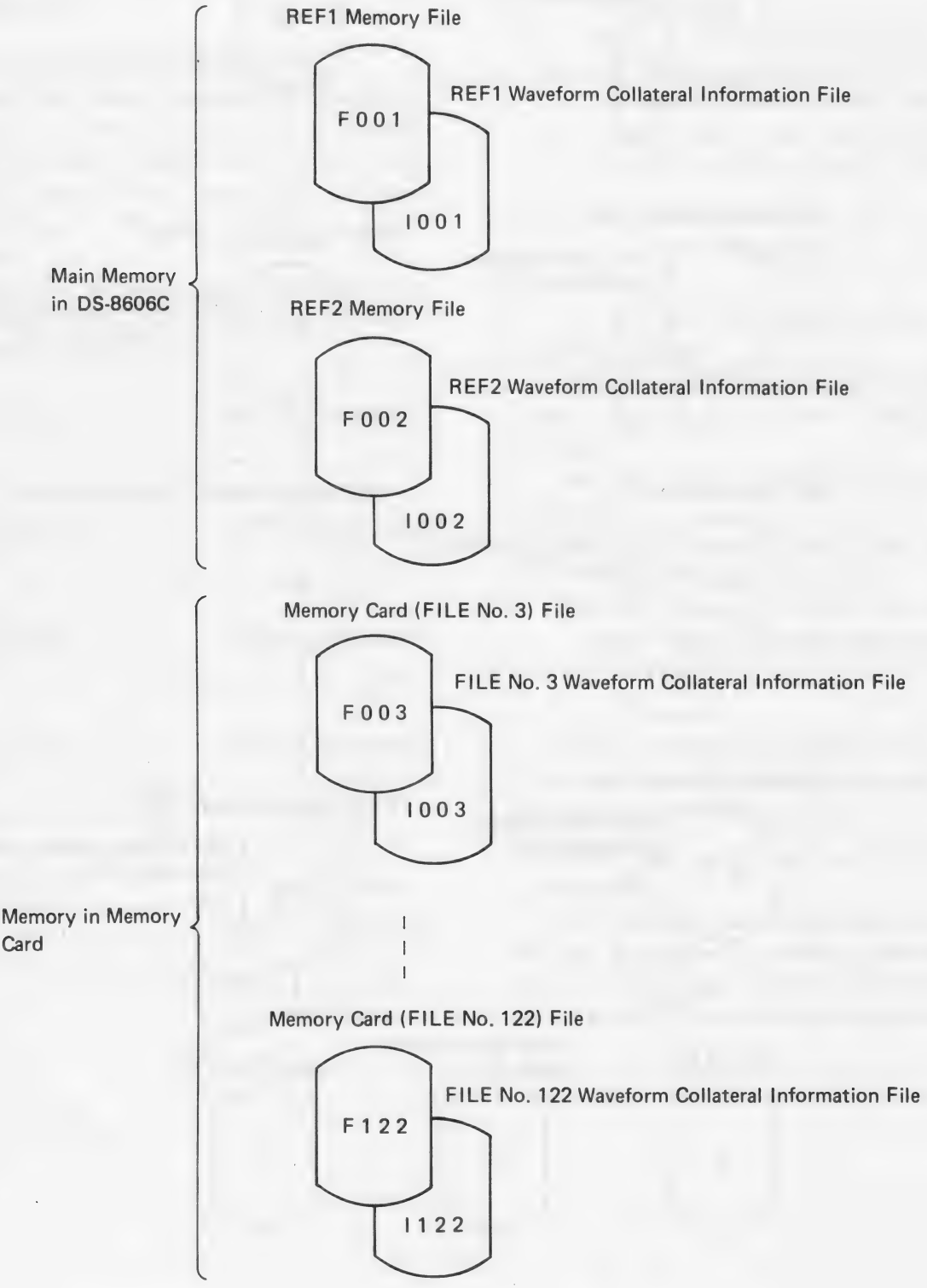
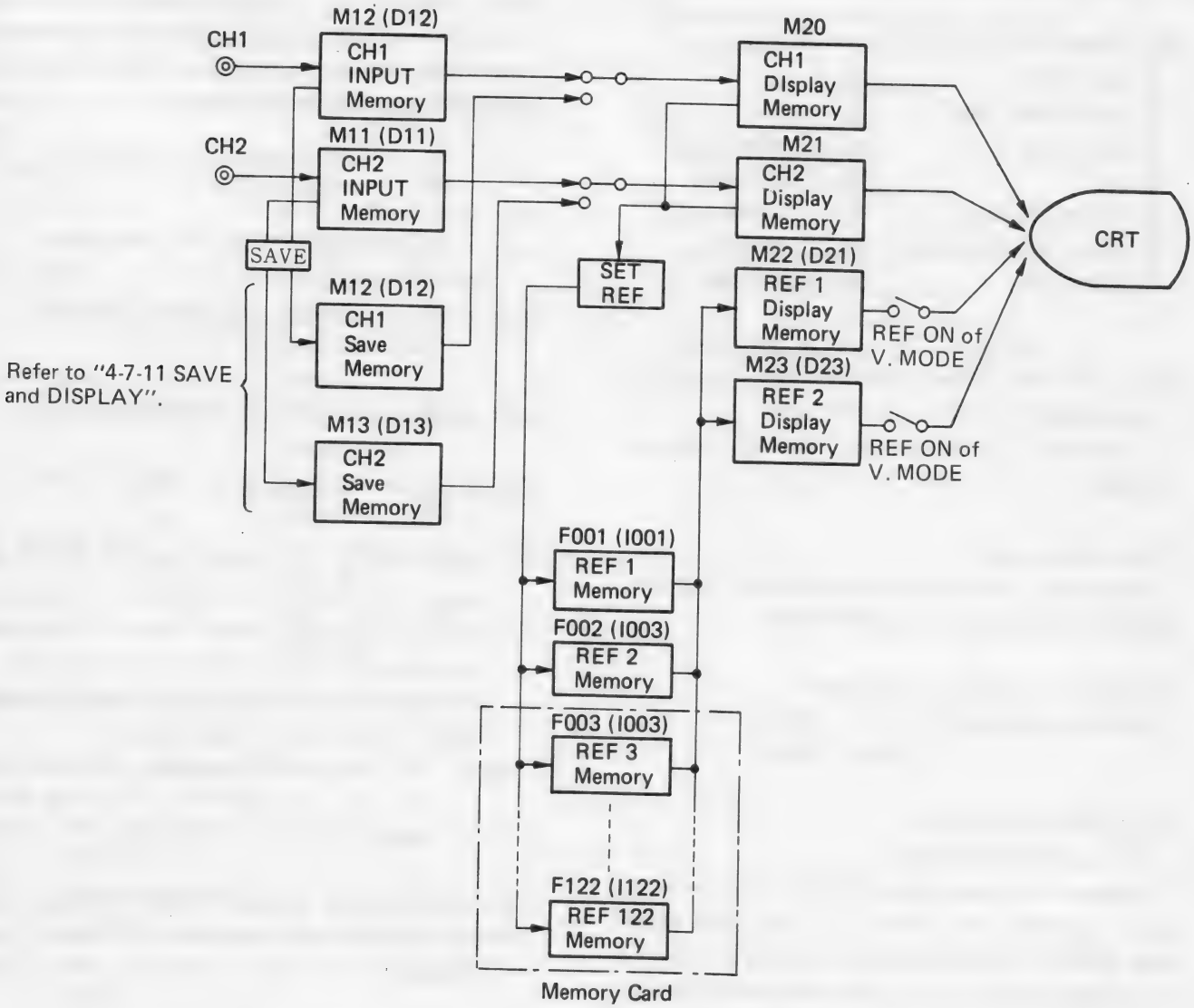


Figure 7-6-4-1. Memory and File



*1 The accessory supports up to REF 32.

d. Sending the Auxiliary Information

Of specified auxiliary information, this instrument output the following items only. (ASCII code)

Basic Transfer Sequence and Format (Example)

1. No. of data	AA ⤶ 7 ⤶
2. No. of binary data	AB ⤶ 2 ⤶
3. Data length	AC ⤶ 16384 ⤶
4. ΔX	AD ⤶ 2.0E–03 ⤶
5. Y-FULL SCALE	AE ⤶ 1.024E + 02 ⤶
6. No. of DELAY WORDs	AF ⤶ –16000 ⤶
7. ZERO value	AG ⤶ –32768 ⤶

⤶ : delimiter ↓ Identification code

- No. of data

  7 are fixed. This means that 7 auxiliary data are provided.

- No. of binary data

  2 are fixed. This means that 2 bytes and 1 data are available in transferring the waveform data.

- Data length (waveform data length)

  With the data length of 1 kw : 1024
  16 kw : 16384

- ΔX (resolution per data)

  ΔX is obtained as follows:

  Assume that a sweep time (SEC/DIV) for the waveform displayed on the screen is T_1, and that a sweep time (SEC/DIV) when capturing the waveform is T_0. T_0 is normally equal to T_1. In the modes other than the ROLL mode, however, it is 5 μs/div when high-speed sweep at 5 μs/div or faster is applied. In the ROLL mode, it is 0.1 ms/div when high-speed sweep at 0.1 ms/div or faster.

  In EQU SAMPLE, T_0 and T_1 are always assumed to be equal.

  From the above, ΔX upon input of the waveform is calculated as follows:

$$\Delta X = \frac{T_0}{100} \quad \text{(except for ROLL mode)}$$

$$\Delta X = \frac{1000 \times T_0}{100} \quad \text{(ROLL mode)}$$

Next, consider the case when the STOP mode is selected after inputting the waveform and panel setting is updated. Assuming that a panel set value after updating (SEC/DIV) is T_2, that the panel set value when maximumly enlarged is T_3 *1, and that the panel set value when minimumly reduced is T_4 *1, ΔX in waveform editing is calculated as follows:

$$\Delta X = \frac{T_0}{100} \quad \text{(Enlargement with interpolation turned off)}$$

$$\Delta X = \frac{5 \times T_2}{100} \quad \text{(Enlargement with interpolation turned on: } T_2 \geq T_3\text{)}$$

$$\Delta X = \frac{5 \times T_3}{100} \quad \text{(Enlargement with interpolation turned on: } T_2 < T_3\text{)}$$

$$\Delta X = \frac{T_2}{100} \quad \text{(Reduction: } T_2 \leq T_4\text{)}$$

$$\Delta X = \frac{T_4}{100} \quad \text{(Reduction: } T_2 > T_4\text{)}$$

*1. After entering the waveform, stop it and set the sweep time (SEC/DIV) otherwise. A range just before the one within which "SET UP" is displayed, in turning the range selector to the direction of enlargement and of reduction, is T_3 and T_4 respectively.

[Note] The waveform displayed also multiplies a SEC/DIV value by 1,000 times, if it is the ROLL mode.

- Y-FULL SCALE (physical amount value converted from the maximum value which the waveform data can assume)

$$\text{Y-FULL SCALE} = \frac{256 \times \text{VOLTS/DIV Value at Waveform Data Input Time}}{25}$$

- No. of DELAY WORDs

  DELAY WORD (for length of 1 kw) = DATA POSITION x (–100)
  DELAY WORD (for length of 16 kw) = DATA POSITION x (–100) x 16

- ZERO value

  ZERO value = GND level value (–32768 ~ 32512)

Indicates ground level value. Shown in the same format as those values obtained by transmitting the waveform data in terms of ASCII code.

e. Reading out the Cursor Measured Value

A type of cursor measurement currently under way and measured values are output in terms of ASCII code with units.

Output data are as follows:

- ΔVOLTAGE : CH1 voltage value, CH2 Voltage value
- ΔTIME : Time value, frequency
- VOLTAGE RATIO : Voltage ratio (%), voltage ratio (dB)
- PHASE : Phase (°)
- GND REFERENCE : CH1 voltage value, CH2 voltage value
- PEAK TO PEAK : CH1 P-P value, CH2 P-P value
- MAX & MIN : CH1 MAX value, CH2 MIN value, CH2 MAX value, CH2 MIN value

(Example) for ΔTIME

2) 1.00E–03) 1.00E + 03)

): delimiter

[Note 1] Data distinguished CH1 and CH2 are output by V-MODE.
CH2V is output in the X-Y mode of ΔVOLTAGE, and CH1 V is output in the X-Y mode of ΔTIME.

[Note 2] When an output result is ∞, "INFINITY" is output.
The following marks may be added:
VARIABLE mark : "<" or ">"
Saturation mark : "<=" or ">="

f. Outputting the Status Sense

Current status sense, such as waveform writing under way or writing end, is output in terms of ASCII code.

Output values have the following meanings:

- RUN status
  - 0 : Non-RUN status
  - 1 : RUN status
- GO/NO GO judgment
  - 0 : GO (non-operating)
  - 1 : NO GO
- Waveform input status
  - 0 : Waveform input end
  - 1 : Waveform input under way

(Example) When waveform writing ends while GO/NO GO is operating: (judged as NO GO)

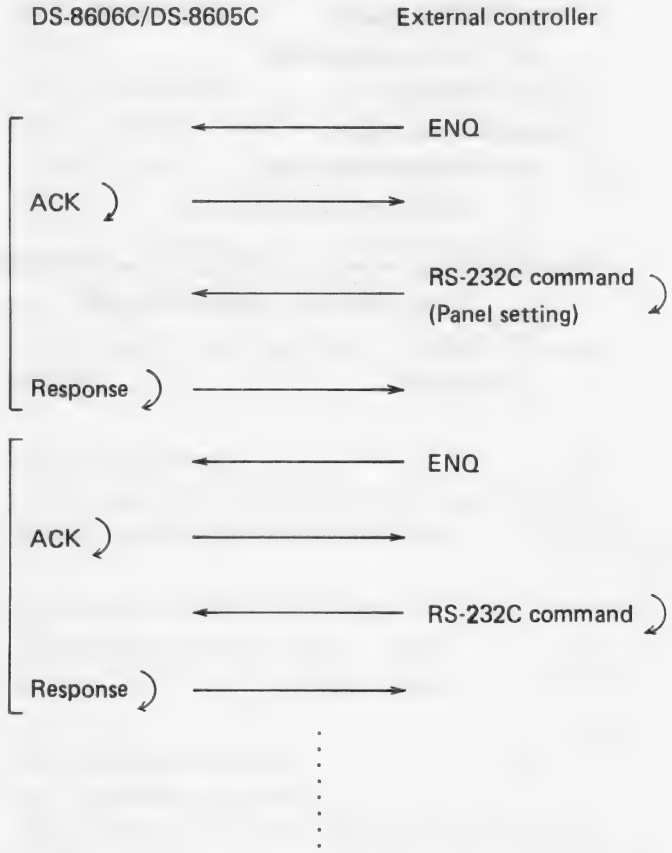
0) 1) 0)

): delimiter

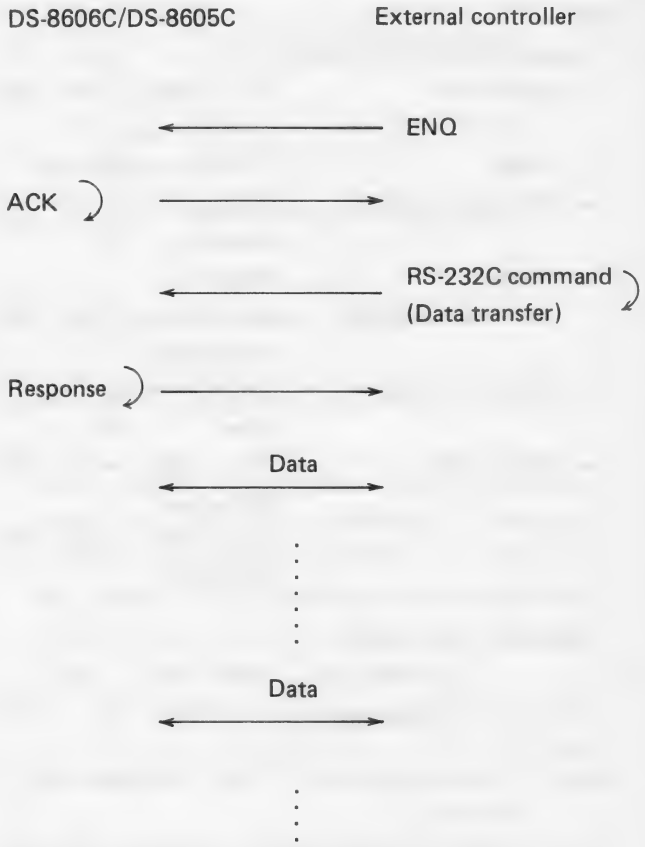
7-7 HANDSHAKE IN REMOTE-CONTROLLING

In remote-controlling this instrument through a external controller, be sure to give the following handshakes.

Panel setting command



Data transfering command



[Note 1] ") " stands for a delimiter.
[Note 2] A delimiter is selected on a menu screen.
[Note 3] For the first ENQ, no delimiter is used.

- It is possible to send or received data only when a response is made "normally".
- It is impossible to remote-control this instrument until it receives a ENQ.
- Give a series of handshakes (sending an ENQ to receiving a response) for every RS-232C command.
- If the next command is not sent just after an external controller sends an ENQ and receives an ACK, this instrument keeps waiting for a command and discontinues its internal operation. So no waveform can be taken in even if a LED for RUN lights.

7-8 RESPONSE

A datum, which is sent back to an external controller after this instrument receives a RS-232C command at handshakes in remote-controlling is called a response.

a. Format

Decimal ASCII (max. 3 digits) + a delimiter.

b. Contents

The following data are sent back to inform of an error in a RS-232C command.

0 ⏎ : Normal
97 ⏎ : Over in the number of characters of a RS-232C command
100 ⏎ : RS-232C command cannot be executed
104 ⏎ : Error in the parameter of a RS-232C command
112 ⏎ : An underfined command is received.

[Note] " ⏎ " stands for a delimiter.

7-9 ERROR DISPLAY

When receiving not correct data by communicative mistake of RS-232 or a noise is made (because this instrument is used under quite unfavorable environment or the cable is in bad condition), an error is displayed.

a. Parity error

A set parity bit does not correspond to the set value. (A parity bit is set in error.).

b. Framing error

No effective stop bit can be found in the last one of each series of data. (Baud rate is set in error.)

c. Overrun error

Before processing the received data, this instrument receives the next data (receives undefined data successively).

7-10 RS-232C COMMAND

This command is given from an external controller through RS-232C to remote-control this instrument.

The multi-statement of this command cannot be admitted.

The RS-232C command is largely common to the GP-IB command. But there are some commands used only through GP-IB and a one to be added and used through RS-232C as follows:

a. Commands used only through GP-IB

Not to be used through RS-232C

1. OTP ␣ 2 ⏎
   Not to be sent to the plotter by remote-controlling this instrument through an external controller.
   OTP ␣ 0 and OTP ␣ 1 are effectively sent.
2. DMA␣
   X : 0 or 1
   A DMA cannot be transmitted through RS-232C.
3. SRQ␣X1, X2
   X1 : 0 or 1
   X2 : A value to be masked (in decimal notation)
   There is no SRQ available for RS-232C.

b. A command to be added and used through RS-232C

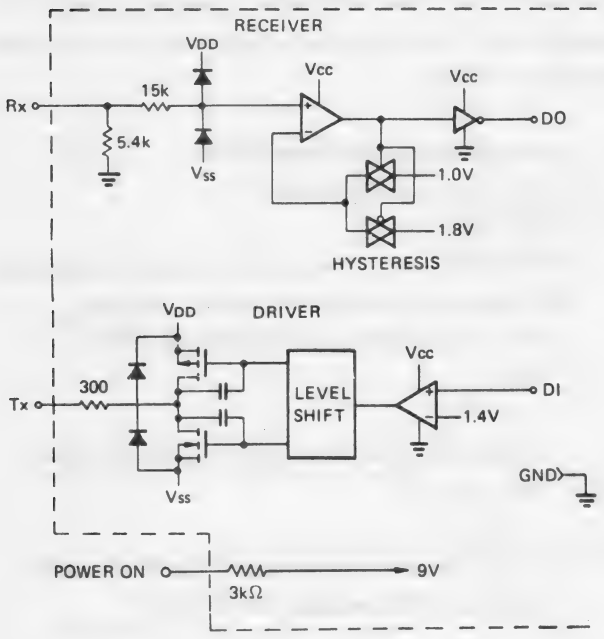
REMOTE release

The commands not listed above are common to the GP-IB commands. Refer to "SECTION 6 SPECIFIC EQUIPMENT COMMANDS" for them.

7-11 INPUT/OUTPUT CIRCUIT AND SIGNAL LINE

Input/output circuit

This instrument is composed of the following input/output circuit.



Signal Line

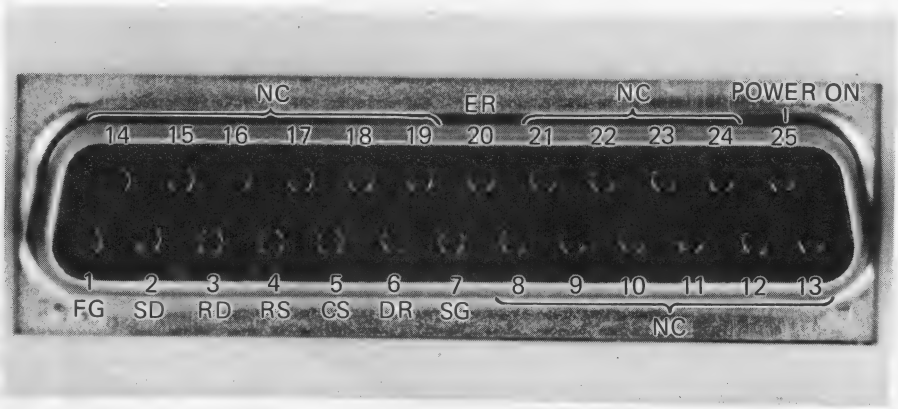
1. SD (Sent Data)
   Mark 1 in "L" output
   Space 0 in "H" output
2. RD (Received Data)
   Logic is the same as the Sent Data.
3. RS (Request to Send)
   Requests sending for the external equipments in active "H". In this unit, "H" is always output.
4. CS (Clear to Send)
   Enables this unit to send in active "H" input.
5. ER (Data Terminal Ready)
   Indicates that this unit can send or receive data in active "H" output.
6. DR (Data Set Ready)
   A signal intended for knowing how the plotter gets ready to work before connecting it (if the power supply is ready or not) and available nomally in "H" input.
7. POWER ON
   This instrument is turned on in "H" output.
8. FG (Frame Ground)
   Grounding for maintenance to the unit's frame.
9. SG (Signal Ground)
   Common grounding for all the signals.

The input/output signal line and the connecter pin No. is as shown in Table 7-11. For the position of the number, see Fig. 7-11.

Table 7-11. Signal Line and Pin assignments

RS-232C Pin No.	Signal Line (Mnemonic)	I/O	Function
1	FG		Frame Ground
2	SD	Out	Sent Data
3	RD	In	Received Data
4	RS	Out	Request to Send
5	CS	In	Clear to Send
6	DR	In	Monitoring the plotter power supply
7	SG		Signal Ground
8 ≀ 19	NC		No connection
20	ER	Out	Data Terminal Ready
21 ≀ 24	NC		No connection
25	Power on	Out	Power on

Figure 7-11. RS-232C Connector and Pin Assingment



7-12 CONNECTION TO EXTERNAL EQUIPMENTS

7-12-1 Connecting Cable

Use the attached cable SX-0102 when connecting to external equipments.

The end of the cable should be adapted to the interface specifications of the external equipment after processing as shown in Figure 7-12-1.

7-12-2 How to Connect a Cable

How to connect a cable depends on whether a DR signal is sent or not. For details of the signal, refer to "7-5-2 Discontinuing sending" and "7-5-3 DR".

Procedure

① Cut the cable to the required length and remove the outer shield about 5 cm.

② Cut the shield-weave line with remaining length of 1 cm, bend onto the shield and cover the attached tube for external equipments after soldering the lead wire for FG (Frame Ground).

③ Connect each signal line to the connecting terminal. Process the unnecessary end of the lines by covering them with heat-contractive tube.

When a DR signal is not sent:

Keep DR (blue) and POWER ON (purple) short-circuited.

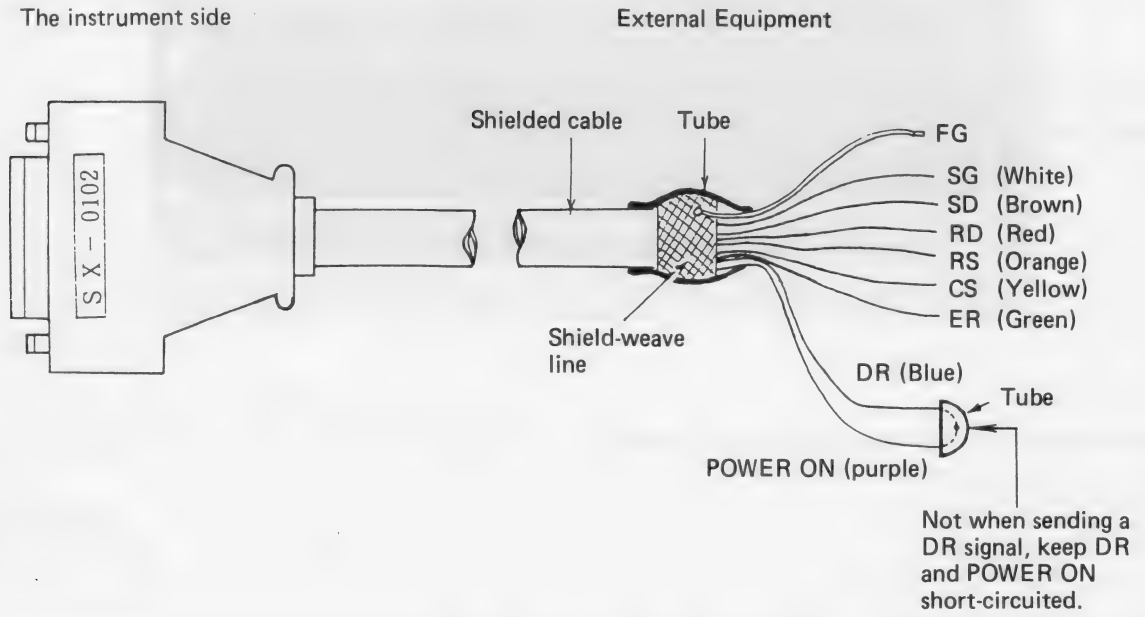
When a DR signal is sent:

Cut DR (blue) off POWER ON (purple), which are already short-circuited, and connect DR (blue) with the connecter terminal for the signal to notify the external equipment is to be put on or off.

In the meantime, POWER ON (purple) shall not be used with a thermal contraction tube shielding it.

For how to connect the cable with the plotter made by IWATSU, refer to Fig. 7-12-3.

Figure 7-12-1. Connecting Cable



7-12-3 Connecting the Cable with the Plotter

It is possible to sent signals to the plotter corresponding to HP-GL. In connecting the cable with the plotter, set the baud rate, the character length, the parity bit, the stop bit and the delimiter of this instrument equal to those of the plotter.

For how to send signals to the plotter, refer to "4-7-12 Output".

Fig. 7-12-3 below shows how to correct signal lines with the plotter, made by IWATSU, corresponding to HP-GL (SR-6620H, SR-6200H, SR-6310, etc.)

Fig. 7-12-3. Connecting with IWATSU Plotter

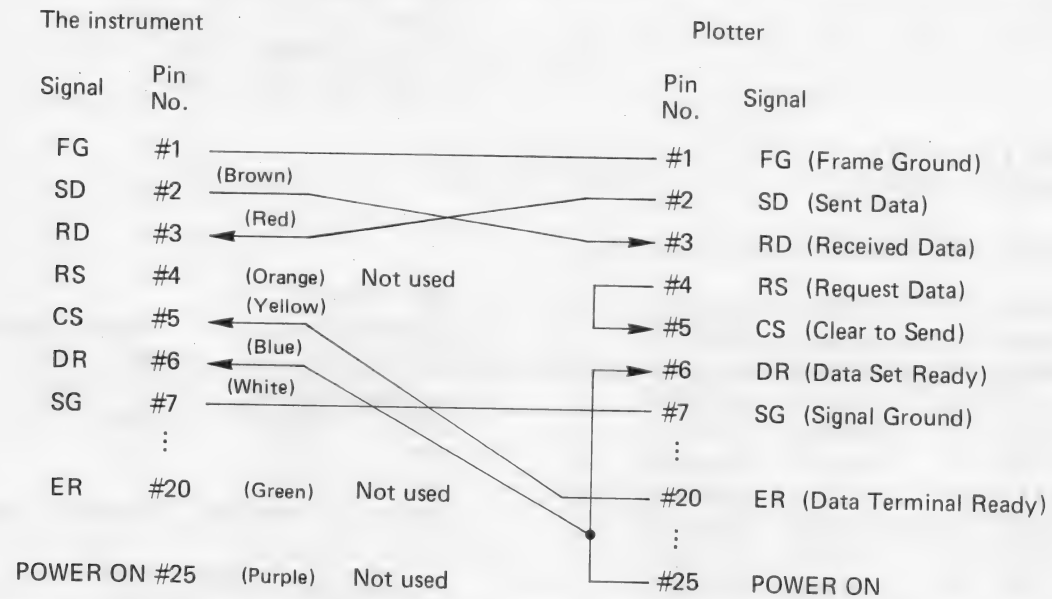
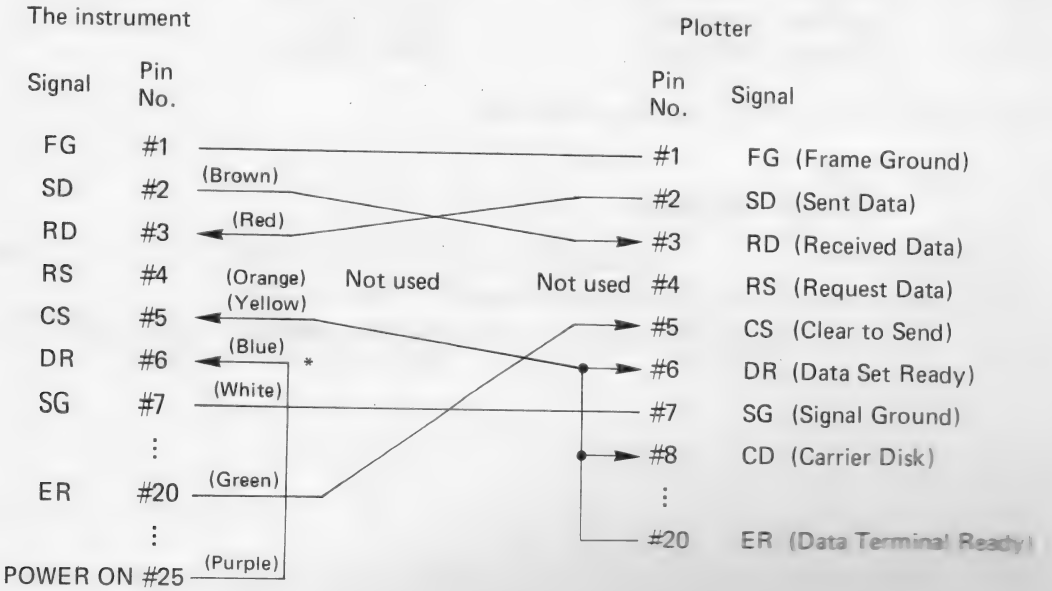


Fig. 7-12-4. Connecting with PC-9801



* An accessory cable has been already connected.

7-13 SAMPLE PROGRAM

Describes two sample programs that use the PC-9801 and HP-216 as external controller.

7-13-1 PC-9801

```
10 '********** DS-8606/DS-8605 RS232C TEST PROGRAM **********
20 '
30 OPEN "COM:N81XN" AS #1                    ' PARITY      : NON
40 '                                         ' BIT LENGTH  : 8 BIT
50 '                                         ' STOP BIT    : 1 BIT
60 '                                         ' X PARAMETER: ON
70 '                                         ' S PARAMETER: OFF
80  CLS 3
90  DIM BUFFER1$(1023)
100 DIM BUFFER2$(1023)
110 '
120 '********** SET SETUP **********"
130 '
140 SETUP$="RUN 0"   :GOSUB *CMDOUT          ' SET STOP
150 SETUP$="MOD 4,0":GOSUB *CMDOUT           ' V-MODE          : DUAL(REF OFF)
160 SETUP$="HDS 1"   :GOSUB *CMDOUT          ' H.DISPLAY       : A
170 SETUP$="ATD 14"  :GOSUB *CMDOUT          ' A SEC/DIV       : 20 uSEC
180 SETUP$="TAS 1"   :GOSUB *CMDOUT          ' TRIG. SORCE     : CH1
190 SETUP$="TAC 1"   :GOSUB *CMDOUT          ' TRIG. COUPL     : AC
200 SETUP$="ATP 0"   :GOSUB *CMDOUT          ' TRIG. SLOPE     : +
210 SETUP$="MES 1,1":GOSUB *CMDOUT           ' STORAGE NORMAL, REPEAT ON(0SEC)
220 SETUP$="DTL 0"   :GOSUB *CMDOUT          ' DATA LENGTH     : 1 KW
230 SETUP$="IPL 0"   :GOSUB *CMDOUT          ' INTERPOLATION   : OFF
240 SETUP$="TMB 0"   :GOSUB *CMDOUT          ' TIME BASE       : INT
250 SETUP$="DSP 0,0":GOSUB *CMDOUT           ' DISPLAY         : INPUT (CH1&CH2)
260 SETUP$="CUR 0"   :GOSUB *CMDOUT          ' CURSOR MESURE   : OFF
270 SETUP$="DTP 0"   :GOSUB *CMDOUT          ' DATA POSITION   : 0 DIV
280 SETUP$="OPM 3"   :GOSUB *CMDOUT          ' SWEEP MODE      : SINGLE
290 SETUP$="RUN 1"   :GOSUB *CMDOUT          ' SET RUN
300 SETUP$="RST"     :GOSUB *CMDOUT          ' SEND RESET
310 '
320 '********** WAIT FOR WAVE IN **********
330 '
340 FOR I=0 TO 1000 :NEXT I
350 SETUP$="JX T"    :GOSUB *CMDOUT
360 INPUT #1,RUNST$
370 INPUT #1,GONOGO$
380 INPUT #1,WRITES$
390 IF WRITES$<>"0" THEN GOTO 350            ' IF NO INPUT, JUMP(RETRY)
400 SETUP$="RUN 0":GOSUB *CMDOUT             ' SET TO STOP STATE
410 '
```

Comment Line number	Contents
30	Initial setting
120 to 300	The instrument setting In practically transfering a command, gives hand shakes to the instrument through subrotines of * CMDOUT at 790 line.
340 to 390	Monitoring it that writing data is finished. Confirming that "0" is displayed in the third item of the status sense output (this means entering a waveform has been finished.), stops taking the data in.

```
420 '********** CH1 WAVE DATA RCV **********
430 '
440 SETUP$="JX M10,1,1,0":GOSUB *CMDOUT
450 FOR I=0 TO 1023
460   INPUT #1,BUFFER1$(I)
470 NEXT I
480 '
490 '********** CH2 WAVE DATA RCV **********
500 '
510 SETUP$="JX M11,1,1,0":GOSUB *CMDOUT
520 FOR I=0 TO 1023
530   INPUT #1,BUFFER2$(I)
540 NEXT I
550 '
560 '********** DISPLAY CH1 & CH2 WAVE DATA **********
570 CLS 3
580 '
590 SCREEN 2,0
600 WINDOW (  0,-128)-(1024,128)
610 VIEW (50,10)-(400,200)
620 '
630 FOR I= 0 TO 1023                          ' DISPLAY CH1 WAVEFORM
640   YY=VAL(BUFFER1$(I))
650   YY=YY/256
660   IF YY>127 THEN  YY=YY-256
670   PSET (I,-YY)
680 NEXT I
690 FOR I=0 TO 1023                           ' DISPLAY CH2 WAVEFORM
700   YY=VAL(BUFFER2$(I))
710   YY=YY/256
720   IF YY>127 THEN YY=YY-256
730   PSET (I,-YY)
740 NEXT I
750 END
760 '
770 '********** COMMAND OUT ROUTINE **********
780 '
790 *CMDOUT
800 PRINT #1,CHR$(5);                         ' OUTPUT ENQ CODE
810 INPUT #1,ACK$                             ' INPUT  ACK CODE
820 PRINT #1,SETUP$                           ' OUTPUT COMMAND DATA
830 INPUT #1,RSP$                             ' INPUT  RESPONSE
840 RETURN
```

Comment

Line number	Contents
420 to 470	Transmitts 1 kword of CH1 input data to the declared array under ASCII.
490 to 540	Transmitts 1 kword of CH2 input data to the declared array under ASCII.
560 to 750	Based on the data stored into the array, display a wave form.
790 to 840	Be sure to give a series of hand shakes; 1 Sending an ENQ, 2 Receiving an ACK, 3 Sending a command, and 4 Receiving a response in practically giving a command to the instrument.

```
10  !
20  !*** DS-8606/DS-8605 RS232C TEST PROGRAM ***
30  !
40  !*** INITIALIZE ***
50  !
60    INTEGER Buffer1(2047) BUFFER
70    INTEGER Buffer2(2047) BUFFER
80    ASSIGN @Buffer1 TO BUFFER Buffer1(*)
90    ASSIGN @Buffer2 TO BUFFER Buffer2(*)
100 !
110   ASSIGN @Device TO 9
120   CONTROL 9,3;4800            ! BAUDRATE 4800
130   CONTROL 9,4;3+4+0           ! 8BIT,NON PARITY,1BIT
140   CONTROL 9,5;0               ! AUTO MODEM CONTROL
150 !
160   GCLEAR
170 !
180 !*** SET SETUP ***
190 !
200   Cmd$="RUN 0"                ! RUN/STOP          STOP
210   GOSUB Cmdout
220   Cmd$="MOD 4,0"              ! V MODE            DUAL,REF OFF
230   GOSUB Cmdout
240   Cmd$="HDS 1"                ! H DISPLAY         A
250   GOSUB Cmdout
260   Cmd$="ATD 14"               ! A TIME/DIV        20USEC/DIV
270   GOSUB Cmdout
280   Cmd$="TAS 1"                ! A TRIG. SOURCE    CH1
290   GOSUB Cmdout
300   Cmd$="TAC 2"                ! TRIG. COUPLING    AC
310   GOSUB Cmdout
320   Cmd$="ATP 0"                ! TRIG. SLOPE       +
330   GOSUB Cmdout
340   Cmd$="MES 1,1"              ! STORAGE MODE      NORMAL,COUNT 2
350   GOSUB Cmdout
360   Cmd$="DTL 0"                ! DATA LENGTH       1K WORD
370   GOSUB Cmdout
380   Cmd$="IPL 0"                ! INTERPOLATION     OFF
390   GOSUB Cmdout
400   Cmd$="TMB 0"                ! TIME BASE         INT
410   GOSUB Cmdout
420   Cmd$="DSP 0,0"              ! DISPLAY CH1,2     INPUT
430   GOSUB Cmdout
440   Cmd$="CUR 0"                ! CURSOR            OFF
450   GOSUB Cmdout
460   Cmd$="DTP 0"                ! DATA POSITION     0 DIV
470   GOSUB Cmdout
480   Cmd$="OPM 3"                ! SWEEP MODE        SINGLE
490   GOSUB Cmdout
500   Cmd$="RUN 1"                ! RUN/STOP          RUN
510   GOSUB Cmdout
520   Cmd$="RST"                  ! SINGLE RESET
530   GOSUB Cmdout
540 !
```

Comment Line number	Contents
110 to 140	Initial setting
200 to 530	DS-8606C/DS-8605C setting Gives handshakes to the instrument though subroutines of Comdout at 980 line, in practically sending a command.

```
550   Cmd$="JX T"
560   GOSUB Cmdout
570   ENTER @Device;Run$
580   ENTER @Device;Gonogo$
590   ENTER @Device;Write$
600   IF Write$<>"0" THEN 550
610 !
620   Cmd$="RUN 0"
630   GOSUB Cmdout
640 !
650 !*** CH1 WAVE DATA RCV. ***
660 !
670   Cmd$="JX M10,3,1,0"
680   GOSUB Cmdout
690 !
700   TRANSFER @Device TO @Buffer1;COUNT 2048
710 !
720 !*** CH2 WAVE DATA RCV. ***
730 !
740   Cmd$="JX M11,3,1,0"
750   GOSUB Cmdout
760 !
770   TRANSFER @Device TO @Buffer2;COUNT 2048
780 !
790 ! *** GRAPHICS WAVE DATA ***
800 !
810   GCLEAR
820   GRAPHICS ON
830   WINDOW 0,1023,-128,128
840   VIEWPORT 0,400,0,200
850   MOVE 0,0
860 !
870   FOR I=0 TO 1023
880     PLOT I,Buffer1(I)/256
890   NEXT I
900 !
910   PLOT 0,Buffer2(0)/256,-2
920   FOR I=1 TO 1023
930     PLOT I,Buffer2(I)/256
940   NEXT I
950 !
960   STOP
970 !
980 Cmdout:!
990   OUTPUT @Device;CHR$(5);
1000  ENTER @Device;Ack$
1010  OUTPUT @Device;Cmd$
1020  ENTER @Device;Rsp$
1030  RETURN
1040  END
```

Comment

Line number	Contents
550 to 630	Monitoring it that writing data is finished. Confirming that "0" is entered in the third item of the status sense output (this means entering a waveform has been finished.), stops taking the data in.
650 to 700	Transmitts 1 kword of CH1 input data to the declared array under binary notation.
720 to 770	Transmitts 1 kword of CH2 input data to the declared array under binary notation.
790 to 960	Based on the data stored into the array, display a waveform.
980 to 1030	Be sure to give a series of handshakes: 1 Sending an ENQ, 2 Receiving an ASK, 3 Sending a command, and 4 Receiving a response in practically giving a command to the instrument.

IWATSU ELECTRIC CO., LTD.

International Department: 7-41, 1-chome Kugayama,
Suginami-ku, Tokyo, 168 Japan
Telephone: Tokyo 03-5370-5208
Facsimile : Tokyo 03-5370-5230

IWATSU